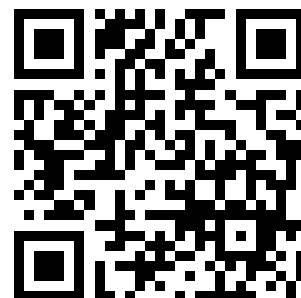

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Mines and Minerals

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COAL MINES OF PICTOU.

A Description of the Mines of the Colorado Fuel & Iron Co., the Methods of Operation, and the Geological Formation.

Written for MINES AND MINERALS, by Frank Meade.

The coal mines of Pictou, Colorado, are located in Southern Colorado along the eastern border of the foothills of the Rocky Mountains, among the pifion hills. The camp is situated about midway between Pueblo and Trinidad on a spur of the Denver & Rio Grande Railroad, which takes out from Walsenburg, the county seat of Huerfano County, about two miles to the south, which is the nearest express office. The celebrated Spanish Peaks, about 20 miles to the south, have from time immemorial formed the principal landmarks in these parts.

The name "Pictou" was given to the camp at the time the mines were opened, some 12 years ago by its first superintendent, the late Thomas Lawther, he having formerly resided in Pictou, N. S. Its population will run from 1,000 to 1,500, being a mixed class of nearly all nations. Fine little cottages are built by the different companies for the accommodation of the miners, the C. F. & I. houses are four-roomed buildings; many, however, have built their own homes.

There are several companies operating mines here, the most prominent being the Colorado Fuel & Iron Co., with a capacity of 1,500 tons daily, employing, when at its full capacity, from 500 to 600 men, the Northern Coal Co., capacity 400 tons daily, employing about 150 men, the Victor Fuel Co., capacity about 500 tons daily, employing about 200 men, all of Denver, and several smaller companies.

All the mines are worked by slope openings, ventilated by upcast fans, equipped with cable haulage, landing the mine cars on trestleworks in order to get fall enough to screen the coal. The coal is dumped by Mitchell tipples over screens into the railroad cars.

The miner gets paid by the ton for what coal goes over the screens, and it is weighed in the railroad car, rods connecting the scales with the weigh house which is on top of the trestle.

The screenings are screened again, each company having a different process, the C. F. & I. produces two grades of nut coal (i. e., nut and pea) by a shaker screen run by a small electric motor, while the slack is shipped to the steel works of the company at Bessemer. The nut coal, before passing into the box cars, is discharged onto an endless apron, where boys pick the slate out as it passes along. All the different mines here are located on the same series of coal veins, which consists of three veins with a 5-per-cent. dip to the west of south.

As the Colorado Fuel & Iron Co.'s plant here is the oldest, largest, and most productive, and as the openings and workings of the different mines are practically the same, I shall confine my description to it.

This company is the only one working all three veins. (For section of workings see Fig. 1.) The top vein, No. 1, called the "Lenox" coal, consists of about 7 feet of coal mixed with more or less slate, i. e., a top coal of 1½ feet, a middle coal of 4 feet, with 6 inches of slate, between, and a bottom coal of 1½ feet with slate between it and the middle coal. The slate is gobbled in the rooms. One of the peculiarities of this vein is the 1½ feet of top coal, or perhaps rather the slate between it and the middle coal. As this coal is followed down on the dip the slate becomes thicker, until, in the bottom of the workings, this slate is 30 or 40 feet thick.

As long as this slate did not exceed 2 feet in thickness it was gobbled in the rooms, but as it becomes thicker it is kept up with timbers, the rooms worked out, and the pillars drawn, after which this slate often comes down, leaving the coal hanging. In such cases track is laid on top of this fall of slate, and this coal is taken out. It requires very little powder, and although a dangerous job, it is considered one of the snaps of the mine. Another characteristic of the No. 1 vein is that its dip is irregular as compared with Nos. 2 and 3, which are very continuous, as will be seen from Fig. 1.

Below No. 1 vein, through 32 feet of sandrock, lays No. 2 vein, the Maitland coal, it consisting of 4 feet of clean coal, with a fine sandrock roof. In most places in this mine the bottom has to be taken up in the roadways to make them high enough for the mules. Very little timbering is required in this vein.

Twelve feet underneath No. 2 vein, through slate rock, exceeds 2 feet in thickness it was gobbled in the rooms, but as it becomes thicker it is kept up with timbers, the rooms worked out, and the pillars drawn, after which this slate often comes down, leaving the coal hanging. In such cases track is laid on top of this fall of slate, and this coal is taken out. It requires very little powder, and although a dangerous job, it is considered one of the snaps of the mine. Another characteristic of the No. 1 vein is that its dip is irregular as compared with Nos. 2 and 3, which are very continuous, as will be seen from Fig. 1.

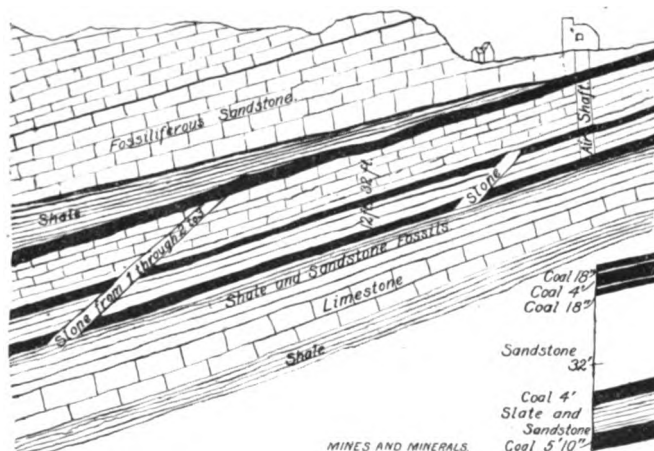


FIG. 1. SECTION AT COLORADO FUEL & IRON CO.'S MINE, PICTOU, COL.

sandrock and soapstone, respectively, comes No. 3 vein, the Cameron coal, the finest coal in Pictou, it being 5 feet 10 inches in thickness, of clear coal; the roof, however, is the poorest of the lot, taking a good deal of timbering, it being necessary in most places to cross-bar it.

Pictou coal is a semibituminous coal, and is known to the trade as a No. 1 steam coal. The analysis of Nos. 1 and 2, as given by Prof. Chauvenet, of the State School of Mines, at Golden,

	No. 1 (Lenox).	No. 2 (Maitland).
Water	2.92	3.10
Volatile matter	41.18	38.12
Fixed carbon	45.36	48.58
Ash	10.54	10.20
Total	100.00	100.00
Sulphur	1.39	2.04

Colorado, is shown in the accompanying table. I regret that I am unable to furnish analysis of No. 3 vein, but it is very similar to Nos. 1 and 2. The coals dip to the west of south with a 5-per-cent. pitch. A peculiar characteristic of this coal is the "nigger-head" form, like

boulders, which it frequently assumes in different sizes, but more frequently the size and shape of pumpkins.

No. 2 slope is under and but a few feet to one side of No. 1 slope, so that the loads from it land on the trestle by the side of No. 1 track and connect with it, near the tippie. The loaded cars pass over the trestle in the middle on either side of these tracks, and but a little lower is a track for the empty cars for either slope. As the empty car passes over the tippie it runs up the pitch in a straight track, which has spring latches, and as the car returns it passes into whichever side these latches are open, and passes along the side by force of gravitation, the track on one side being for No. 1 and the other for No. 2. Headblocks keep these empties from running down the slope. When sufficient empties have accumulated on either side they are coupled together, the rope is fastened on, the headblock is lowered, and the trip is rung away for the inside; the slope being of sufficient pitch to carry the empties back into the mine.

The engine house is situated directly under the trestle, a little forward of the knuckle, and consists of two drums, run by a 65-horsepower Jackson engine, which power is to be doubled this summer we understand. A 96-horsepower Norwalk air compressor is also in use.

The steam plant consists of six single boilers with both suction and force draft, the former has a chimney some 65 feet high, the latter a 6-foot steel fan of 250 revolutions. The trestle-work is some 300 feet long, 36 feet high, and about 30 feet wide.

The electric plant is the finest in these parts, and consists of two General Electric generators of 112 horsepower each, run by compound condensing engines, direct connected, of 150 horsepower each. All the mine machinery, such as pumps, mining machines, etc., are connected with the electric plants by an underground No. 0000 B. & S. gauge copper wire, the line being about 2,600 feet in length.

This mine is supplied with a powerful pumping plant and although the flow of water is only about 400 gallons per minute, keeping only one pump in active operation at the present time, yet it can be said that the mine is supplied for all emergencies. The pumps are three in number (located near the bottom of No. 1 slope), i. e., a Dean pump of 1,400 gallons per minute capacity, run by a 150-horsepower electric motor; one Dean pump of a capacity of 600 gallons per minute, run by an electric motor of 110-horsepower, and one Snow pump of 600 gallons capacity, run by compressed air, fed by a 6-inch air line. This Snow pump is held as a reserve in case of accident to the electric plant.

Pictou has been invaded during the past two years by mining machines, the Jeffrey electric chain coal-cutting machines being the ones now most in use. One of these machines will mine from 100 to 200 tons of coal per day. The No. 2 vein seems especially adapted to them, it having a fine sandrock roof allowing the rooms to be driven 100 feet wide or more. The machine work is all contract work, the machine man getting so much per ton and hiring his help.

All machinery in and around the works, excepting the hoisting plant is run by electricity, and the buildings, trestleworks etc., are lighted by it during the night.

Pictou coal is worked by the room-and-pillar system, rooms being driven 7 yards and entries 3 yards wide. Back entries to facilitate the ventilation of the mine are driven parallel to each entry. The main slopes, i. e., Nos. 1 and 2, are driven 7 by 10 in the clear, No. 1 being about 2,400 feet long. It follows down the dip of the coal, and is well timbered for a short distance with sawed timbers, set with about a 6-inch batter, but after the formation is well caught very little timbering is required, except in places. No. 2 slope pitches sharply through the rock formation

at first, until the coal is reached, after which it follows the coal down the dip as in No. 1 for about 200 feet, when it dips down through the rock formation into No. 3.

Both No. 2 and No. 3 veins are worked from each slope, the slopes having been sunk into the No. 3 vein only during the past two years. Most of the coal, since the opening of the mine, has been taken from the No. 1 vein, so that No. 2 and No. 3 are practically untouched. Within the past year the No. 2 slope has been driven on the No. 3 vein, connecting No. 2 slope with No. 1 slope in the bottom, so that now, as will be seen from Fig. 1, the company has a very large field of coal blocked out. The tracks of the mine are laid on pifton ties with a 3-foot gauge. Thirty-pound rails are used in the slopes, while the ordinary rails of the mines are 16 pounds.

Nos. 1 and 2 veins are timbered mostly with pifton props, the pifton is a species of pine that thrives only on the dry rocky knolls of the prairie and along the foot of the mountains, yet it produces a nut, which, with the children of this clime, takes the place that beechnuts do in the East; it looks somewhat like a stunted pine, it does very well for props, however, and as stated, Nos. 1 and 2 veins are mostly timbered with it. No. 3 has a poorer top, being composed of soapstone, and the timbers used in it are chiefly mountain spruce. The entries are all cross-barred, and the rooms are cross-barred over the roadway, the bar being notched into the rib and the other end resting on a leg, two rows of props on the gob side generally completing the timbering of a room. Each 400 feet along the slopes, entries are driven on both sides on a water level, rooms being turned off the entries "up the hill." Sometimes, however, cross-entries are driven up the pitch instead, and rooms turned off at right angles on either side. In such rooms the loaded cars are pushed out of the rooms and spragged down the hill on to the main entry. In the rooms that turn off the main entries the cars are also spragged down to the entry, in either case the driver hauls the car into the face of the room with his mule, and on the entry when he has enough loaded cars for a trip he couples them together and hauls them out to the main slope, here the rope runner attaches them to the cable and takes them outside.

The coal, except where mining machines are used, is mined by shooting off the solid, a 6-foot hole and 30 inches of powder answering the purpose in most cases. For drilling holes for shooting, the post machine is most extensively used.

Drivers, timber men, and all inside company men receive \$2.60 per day, the digger calculates to make more.

The ventilation of the mine is produced by a 25-horsepower "Guibal" suction fan, 20 feet in diameter, placed over a shaft some 60 feet deep, the shaft penetrating through all three veins. Air enters the slope mouths, passes around, and returns to the air shaft at its intersection with each vein, that is, the return air is passed into the air shaft in each vein separately; no air after traveling around one vein of coal being carried into another. As usual in such mines, the air is forced around where it is needed by doors, curtains, crosscuts, etc., and crosses the slopes by overhead bridges. The fan is now run by electricity; its speed being regulated by a rheostat. The steam plant that formerly operated it is also retained so that the fan is now equipped with both steam and electricity.

All underground work is carried on by naked lights, there never having been any difficulty experienced in keeping the workings clear of what little gas is given off by the coal; however the fireboss makes his round every day before the men go in and leaves his chalk mark on the different places.

Before the opening of the coal mines here at Pictou the place was known as Sulphur Springs, the name being derived from a group of sulphur springs that issued from a small rocky hill just below the coal crop. The water was soft, but too warm to be agreeable for drinking, unless allowed to stand over night, when, the gases having escaped, and it having cooled, it was not bad stuff to drink. It was hauled to Walsenberg and sold for drinking purposes, for years, at 40 cents per barrel, and ever since the opening of the mines the "water wagon" has been one of the crying necessities, as nearly all the drinking and cooking water comes from these springs, and costs, delivered around the camp, 15 cents per barrel. Many wells were sunk, but only a few obtained water. The mine has always had enough water to necessitate a fairly strong pumping plant, but this never seemed to affect the flow of the springs.

A little over a year since, after sinking the slope from No. 1 into No. 3, in driving an entry in No. 3, the floor for several feet square hove up and a powerful head of water rushed in, flooding this part of the mine before many of the miners could get their tools out. Through the untiring energy of the superintendent then in charge, the water was kept back from flooding the rest of the mine, while a large electric pump could be ordered, shipped, and placed in working order; then for months the water went down gradually until at last the water was all out, now these

great pumps make holiday sport of this water. But when this water broke into the mine the bottom fell out of all the wells in camp, and these springs that from remote ages had furnished man and beast with a substitute for good water, ceased to exist. In two days' time there was no water in either. Since then the water for the camp has been pumped from the mine; it seems to be the same as that that formerly came from the springs, i. e., a soft water, strongly impregnated with sulphur.

Pictou coal fields lie in the upper Cretaceous formation, i. e., the Laramie. In the "bone" that is often attached to the coal, however, leaves like the beech leaf, and small bivalve shells occur in a fossiliferous state. Above the coal is a thick bed of sandrock that is more or less fossiliferous; some of it has been metamorphosed (apparently by heat) into quartzite, some very fair specimens of reeds of the Laramie coal period occur in this sandrock as also mollusks, shells, and a few ammonites.

A short distance below the coals is the outcrop of a stratum of limerock that contains large quantities of *Baculite* fossils.

encountered, and in driving through it the No. 2 coal is encountered showing an up-throw of over 30 feet. These changes in the coal show conclusively that the dikes are a late acquisition to this country, geologically speaking. These dikes stand up over the country, in some cases, over 100 feet.

Water-Tube Boilers and Forced Draft.

We do not hear so much nowadays about boilers being damaged and trial trips lost on account of the use of forced draft, but about 10 years ago this was a complaint not at all uncommon. A part of the reason for the change is, as will be seen later, the increased use of water-tube boilers; but, nevertheless, the known fact that forced draft can be used within limits on any boiler with decided advantage suggests an examination to determine, if possible, what those limits are.

As was already remarked, the advent of water-tube boilers has removed this question of damage done to the tube ends by high rates of combustion from the region of practical considera-

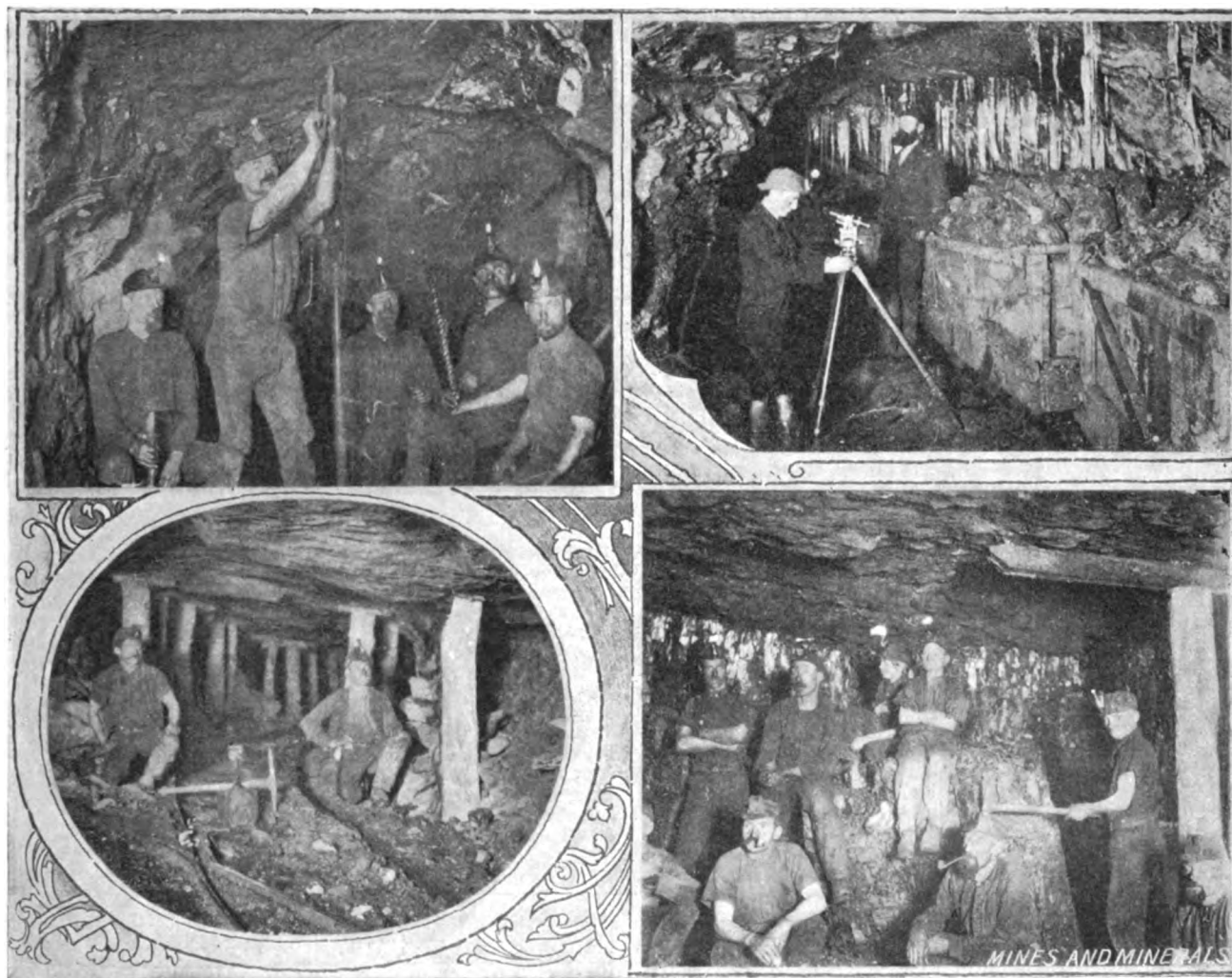


FIG. 2. VIEWS IN PICTOU

Some of these are very beautiful as they glisten in the sunlight with their coatings of mother-of-pearl and their joints as perfect as the day when first they ceased to live. Below this again lies a thick bed of shale several hundred feet thick. A few miles to the east of Pictou, in lime ledges, occur splendid specimens of ammonites, as also many other Cretaceous fossils. All rocks coming from the mines are strongly impregnated with magnesia.

The nearest mountain, called Silver Mountain, lies about 13 miles to the west; it is a laccolitic mountain, and porphyritic dikes, generally only a few feet wide, extend from it through the foothills and through the coal, cutting it from the east to the west. These dikes, or "hogbacks," as they are called, run parallel to each other, and vary from half a mile to a mile or more apart. These dikes have coked the coal from 15 to 20 feet on either side, and, in some cases, have shifted the formation; as for instance in the "South Side" in Pictou mine, about half a mile from the slope; in an entry in No. 1 vein a dike is

tion, owing to the fact that in well designed boilers of this type, where there is any adequate provision for expansion, there has been no case of damaged tubes, however rapid the combustion. At a recent engineering congress, Mr. C. D. Mosher gave a report of a test of one of his boilers, where the air pressure was 12 inches of water, giving an evaporation of 18.2 pounds of water per square foot of heating surface. In the trial of the Ward boiler, prior to its adoption for the U. S. S. Monterey, the rate of combustion was 55 pounds per square foot of grate for a period of 24 hours, without any damage whatever, and in a short test of the boiler of the U. S. S. Cushing, with an air pressure of 4 inches of water, the rate of combustion was higher than 66 pounds per square foot of grate, without any damage. Indeed, this was one of the reasons which led to the readiness with which the water-tube boiler was accepted, although, of course, the prime reason was the reduction in weight.—Walter M. McFarland, in *Engineering Magazine*.

GREAT SALT LAKE

And Its Waters—A History of the Early Exploration That Led to Its Discovery.

Facts Shown by the Survey Made by the United States Topographical Engineers in 1849-50 and an Account of an Expedition Upon It by the Author in 1891.

Written for MINES AND MINERALS, by Don Maguire.

In taking an inventory of Utah's mineral wealth, it would not be correct to place her great inland salt sea as amongst the small items of her resources. In length this wonderful body of water is at present from northwest to southeast 76 miles, and from east to west, at its greatest width of water surface, a little over 36 miles. The surface area of the waters of this lake is about 2,100 square miles. It is one of the greatest bodies of inland salt water on the earth, and presents one of the most interesting examples of its kind in the world.

The first knowledge of this wonderful body of salt water came to the people of the United States from trappers who were in the service of the Hudson Bay Co., or in the employ of the American Fur Co., or members of what was then known as the Association of Free Trappers, and who, wandering into this then distant drear and unknown region, brought back wonderful tales to the American settlements along the Mississippi relative to an inland salt sea that lay far to the westward, surrounded by steep mountains and barren deserts, the few inhabitants of which were the most barbarous and loathsome of humanity. Even earlier than the 18th century vague statements were made by many of the early French explorers regarding this lake. In the year 1689, Baron Lahontan, the then Lord Lieutenant of the French province of Placentia, in New Foundland, made a voyage of conquest and discovery into the regions of the great west. No doubt the Baron Lahontan visited most of the country along the great lakes, also the Wisconsin River, and still farther west and northwest along the Mississippi and Missouri Rivers, but beyond that he seems to have incorporated into his own personal observations much of the reports and statements made to him by the various Indian travelers and hunters whom he met in his wanderings. The North American Indian was never a good geographer, and as a consequence the map furnished to the world by the Baron Lahontan, for the existence of much of which he depended upon Indian descriptions, is, to say the least, very faulty and vague, and its errors are very many, but not greater than those made by the map makers who for 3,000 years furnished to inquisitive mankind what purported to be maps of central Africa and the sources of the River Nile.

For more than 300 years the region in which Great Salt Lake lies was a part of the immense possessions of the kingdom of Spain, but we are not aware of any report being now in existence made by any Spanish explorer relative to this lake or its surroundings. The expeditions of Coronado and Cabeza de Vaca do not seem to have sent any of their forces as far north as Northern Utah, in which this lake lies, but as these expeditions from

Mexico established settlements in New Mexico and Arizona there is little doubt but that exploration was carried as far north as Great Salt Lake, and even beyond to the South Fork of the Columbia River, or what is now known as Snake River. It is quite likely that members of the Franciscan orders of monks, or the Jesuits from old Spain, in the 16th, 17th, and 18th centuries visited the region in quest of converts to Christianity; but if so we have no record yet preserved to our own times of the fact, and the Indian traditions do not tell of any farther north than the Virgin River in Southern Utah, where Padre Escalante carried on missionary work amongst the wild tribes of that region.

Although the country was a possession of Spain until the time of Mexican independence, it remained a comparatively unknown wilderness, and when Mexico became independent its government was too weak to undertake expensive voyages of discovery into its vast northern possessions. In the meantime the restless trappers and traders of Canada and the United States visited the east shores of the lake, and by the year 1805 the fact of its existence became pretty well known to those interested in western exploration.

The work of Lewis and Clarke, as projected by the Government of the United States, did not extend as far south as Utah, the region being then a Spanish possession, and the country

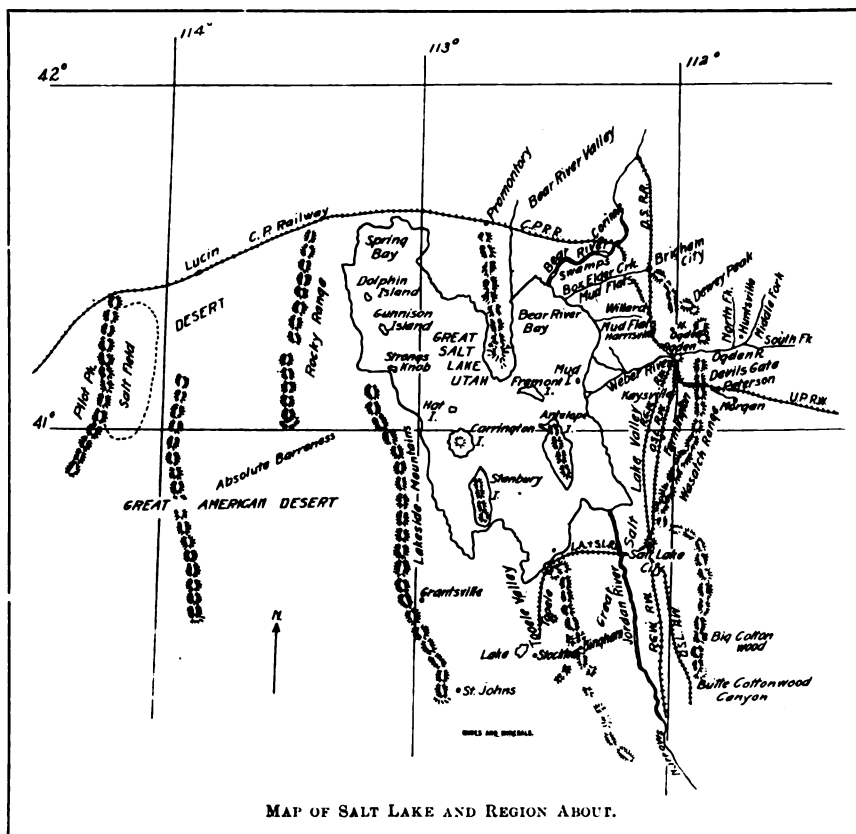
ceded by France during the Consulate of the First Napoleon reached only to within about 70 miles of the then Spanish boundary line north of Great Salt Lake.

An expedition under the auspices of John Jacob Astor was sent across the country overland from St. Louis, Mo., to Astoria, Ore., on the banks of the Columbia River; but none of the members of this expedition visited the Lake, although they passed down the South Fork of the Columbia, about 140 miles to the north of the north end of Great Salt Lake.

In the year 1833, another expedition of discovery, under the leadership of Captain Bonneville, crossed the plains by way of the South Fork of the Columbia or Snake River, and when at Soda Springs, in what is now the State of Idaho, he organized a side expedition to go from Soda Springs by way of Great Salt Lake, and on to Southern California to the Spanish settlements, and there open

trade with the inhabitants, for which purpose he sent with this California contingent a large lot of merchandise to exchange for furs, specie, or such other kind of exchange as would return a high profit on the venture. The leaders of this expedition were instructed by Captain Bonneville to treat kindly and in a diplomatic way all of the native tribes met with on the way to California, so that in future it might pave the way to pleasant intercourse between these native tribes and the American who might visit the country.

These injunctions were not observed, for the members of the California expedition were no sooner in sight of the Great Salt Lake than they got into trouble with a band of Piegan Indians on the banks of Ogden River. The trouble arose about a few traps which the Americans claimed had been stolen from them by the Indians. A fight ensued in which about 20 Indians were killed, and the members of the California expedition were compelled to leave the region as rapidly as possible, and without obtaining any valuable information relative to the Great Lake. They passed on to California, and returning the next year again met their leader, Captain Bonneville, at Soda Springs. Thus again a very important opportunity was lost to learn something of value relative to the wonderful inland sea. In the meantime various trappers



MAP OF SALT LAKE AND REGION ABOUT.

of more than ordinary intelligence visited the Great Salt Lake Valley and told their comrades much of its wonders. Kit Carson, Captain Sublette, Mr. Ashley, Pegleg Smith, Bill Williams, and Peter B. Ogden each visited the country, and the latter, Peter B. Ogden, a trusted agent of the Hudson Bay Co., established a trading and fur post in Great Salt Lake Valley, on the river that now bears his name, at a point half way between the base of the Wasatch Mountains and the eastern shores of the lake. This post was occupied for many years, and the knowledge of the country thus obtained by its occupants was of much benefit to American officials who visited the country in later years.

In the year 1843, Captain John C. Fremont, on his famous overland voyage of exploration from St. Louis, Mo., to the Pacific Ocean, visited Great Salt Lake, and to him we must give the glory of being the first white man of whom we know who ever navigated the waters of Great Salt Lake.

This took place on the ninth day of September in the year 1843. His companions on this occasion were the famous Kit Carson and two Frenchmen, one named Bernier and the other Basil Lajuenesse.

Their camp was in a bend of the Weber River, where they had prepared a small fort to protect themselves and horses and mules from the Indians. At the fort, Captain Fremont left three persons, Badeau, Deroseur, and a negro named Jacob. The boat used by Captain Fremont, on this occasion, was of rubber and in a poor state for the work to be done.

There was much doubt as to the wisdom of the undertaking, as the early trappers and Indians entertained the most superstitious ideas regarding the lake, even the intrepid Carson did not like the undertaking, but the party pushed forward, and on the ninth day of September, 1843, the first white man who ever put foot on an island of the great lake was John C. Fremont. They landed on what they called Desolation Island, but which is now known as Fremont Island. This island lies about three miles from the east shore of the lake, and about 18 miles west of the present city of Ogden.

They found the island uninhabited and covered over with fairly good grass, also artemisia or sage brush, and what is known in Utah now as greasewood. There were no animals and only one spring, the waters of which were somewhat brackish. The formation of the island they found to be a decomposed micaceous slate, interspersed with bands of quartz in which there existed more or less cubic pyrite.

Remaining over night on this island, Captain Fremont returned to the main land and continued his overland journey to Oregon.

His description of the lake and the island is beautiful, only that he described it as wild and weird. The screaming and clatter and chatter of the countless water fowls, such as pelicans, bitterns, wild duck, and geese, that lined the shores of the lake and floated on its waters, made the air alive with their cries, and the mournful dashing of the surf against the rocky shores was not soon to be forgotten.

But an event was soon to occur that was to change the political condition of this then little known and weird country. War broke out between Mexico and the United States, which ended in California, Utah, Nevada, and New Mexico being ceded to the United States, and thus Great Salt Lake became a Yankee possession. This took place in the year 1847, and in this same year the Mormons, under their leader, Brigham Young, crossed the plains and settled in the valley of the Great Salt Lake, on its east shores, where the waters from the high Wasatch range of mountains afforded them opportunity for irrigating the rich black soil of the valley.

About this time there was an immense immigration to Oregon, and the next year the gold excitement to California, all of which events brought Great Salt Lake into much prominence as an important wayside feature.

It was now, in the year 1849, that the United States Government, during the administration of President Fillmore, ordered an official exploration and survey of the Great Salt Lake to be made. This important work was intrusted to Captain Howard Stansbury, of the United States Topographical Engineers, and on the thirty-first day of May, 1849, Captain Stansbury, having in his party 18 men with five wagons and 46 horses and mules, began his expedition to Utah for the famous survey. For the entire distance of 1,200 miles, from Fort Leavenworth to Salt Lake, Captain Stansbury carefully took notes by the way, touching the flora and fauna of the country passed over, also of the mineral prospects of the region traveled over. The various tribes of Indians met on the way he found friendly, and placated them in every way possible, that those coming after him might the better find them friends. The survey party arrived in Salt Lake City in October, 1849. He, in company with Lieutenant Gunnison, began the work of survey, and for nine months this party were busily engaged in the work of surveying the great lake, the

results of which are our only points of dependence as to area, etc., to this day.

His work consisted, first, in making a journey around the lake, which was in those times a work of danger and suffering, inasmuch as in penetrating the region west of the lake there was neither water nor any kind of forage; and at one part of this journey he was compelled to go 70 miles without water, losing four head of their mules, that perished from thirst.

He was doubtless the first human being who made the journey around the lake, and the distance so traveled by him on this occasion was 412 miles.

The actual distance around the lake, following the water line, is 307 miles, but Captain Stansbury was compelled to follow a course in many places far from the lake, in order to reach mountain peaks to be used as triangulating stations during the survey; and he was compelled to travel far from the lake at many points, in order to obtain fresh water and grass for his pack and saddle animals. On two occasions the entire party came near to perishing for want of water, and it was with the greatest difficulty that they at length reached the green meadows that existed then near where the town of Grantsville now stands, 40 miles southwest of Salt Lake City. In crossing the 70-mile desert west of the lake, Stansbury came across the wreck of an emigrant train which two years before had attempted a passage of this route on their way to Oregon. The persons composing the party either succeeded in making their escape by abandoning their wagons and animals, or else wandered away into the desert farther west and perished. In the wagons so abandoned in the wilderness Captain Stansbury's party found abundance of merchandise, clothing, guns, scientific instruments, medicines, drugs, women's wearing apparel, and even jewelry. To this day the history of this lost party is unknown. What a beautiful opportunity for the novelist!

Early in the spring of 1850, Stansbury continued his work of survey of the lake. Every island of the entire lake was visited. Of these islands there are eight, viz., Antelope, Stansbury, Carrington, Hat, Fremont, Egg, Gunnison, and Dolphin; the largest being Antelope, which is 16 miles in length and 5.25 miles in width at its widest point. Stansbury Island is next in size, which is 11 miles in length by 4 miles wide. Fremont Island is 5.50 miles in length by 1.5 miles in width. Carrington Island is 2 miles by 2 miles in area. Egg, Hat, and Dolphin islands are small insignificant dots in the lake, without water or soil, and are only the nesting places of various timid aquatic birds.

Antelope Island is an oblong mountain rising out of the lake, its highest point being about 3,000 feet above the lake's surface. On its sides near the summit there is considerable piñon pine, cedar, and juniper, and on its east side a number of fine fresh-water springs, with a considerable area of excellent soil. On Fremont Island there is only one spring of water, and this is quite brackish. On the remaining six islands there is no water. Captain Stansbury's survey of the Great Salt Lake was most exhaustive. He visited every island, went around the promontory that runs 16 miles into the lake from the north, and made 93 soundings at different parts of the lake. Adding together the various depths so obtained, and dividing them by 93, the number of soundings, we find the average depth of the lake at that time to have been 13.25 feet, and the greatest depth found was 36 feet, and a great part of the lake's depth was found to be from 16 to 30 feet. The above survey was completed in the year 1850, and Captain Stansbury and his party returned to Fort Leavenworth in the autumn of the same year. His report was issued by the United States Government in the year 1852, and remains to this day the most exhaustive official report on America's inland sea.

The writer will now turn from the reports of Fremont and Stansbury to his own observations and discoveries upon this interesting body of salt water. He first visited the lake in the year 1871, 22 years after Stansbury had completed his survey. Even in 1871 the shores of the lake were little frequented save by a few cattlemen who pastured their herds on Antelope Island, and also, during the winter months, on Stansbury Island. Returning to Utah, some years after my first visit, I desired seeing the various islands of the lake, also the promontory, and to measure the depth of the lake westward from Ogden to its western shore, as I then believed that a railway could be built across the lake to Lucine on the Southern Pacific Railway line, thus cutting off the great horseshoe formed by running up to Corrine and promontory and thence over sharp inclines and grades to Lucine.

For the purpose of making this voyage, my party used an old staunch sailing boat, built at Farrington, on the east shore of the lake. She had been constructed to carry wood and cattle from Antelope Island to the east shore of the lake. This vessel was about 75 feet long and 16 feet across the beam, very strong, and well suited to resist the terrible squalls that are so common on Great Salt Lake, and named the Argo.

Three persons accompanied the writer, Daniel McEa, a newspaper editor, of Salt Lake City, Matson M. George, and Auth Edwards, of Ogden, Utah. To manage the vessel we had for a captain one George V. Mortin, who in his early years had been a skipper in the Indian ocean, a young English sailor, a Calabrian whose life had been spent around the stormy coast of Eastern Sicily, and two Portuguese sailors. We had on board the vessel water and food supplies for a two weeks' voyage, and feeling ourselves secure for the work in hand, we left Syracuse bathing resort, on the east side of the lake, in the latter days of July, 1891.

With good weather and fair wind I do not think there is a more agreeable body of water upon the earth's surface on which to sail than Salt Lake. Our first evening's sail brought us to a small bay on the southeast coast of Fremont Island. We dropped anchor at 8 o'clock in the evening. The water at this point is as clear as crystal and the depth about 12 feet, with a gravelly bottom on which millions of white quartz pebbles lie scattered. The night on which we anchored here was favored with a full moon, and the sky was perfectly clear, and the low wind created enough ripple to give a pleasant sound as the tiny waves beat against the shores of the island. On the clear air of evening we could distinctly hear the quacking and snapping of the pelicans that have their habitation on Pelican Island, many miles to the westward. There is an indescribable grandeur and majesty in a moonlight scene on this lake. The Wasatch Mountains, to the eastward about 16 miles away, seemed to rise up to double their natural height, and their bold, wild, and ragged outline rose clearly against the sky, and equally so with the ranges south and southwest.

Our supper was eaten on the deck of the Argo, and in the soft moonlight we planned our work and our probable discoveries during the week to come.

Being well acquainted with the explorations of Fremont, Stansbury, and others who had sailed over the waters of this wonderful salt sink, my mind wandered back to the days when those two men, now in their graves, anticipated the strange sights they were to behold in the lake and on its many islands, just as we were about to do. What a strange old history from a geological point of view this lake has known. From the ancient days, when its waters covered well nigh ten times its present area, when it was a broad fresh-water lake, and poured its mighty tributaries into the Pacific Ocean by way of the Portneuf, Snake River, and Columbia. In those old days its waters teemed with abundant fish life. It was well nigh 600 feet in depth, and in winter its surface was covered with thick ice, which, breaking in the spring, was swept by the southwestern winds against the eastern shores, that extended, in those days, far up upon the Wasatch Mountains. On these sections of broken ice that floated from around the islands were carried great quantities of the micaceous slate fragments, that, beaten into a pasty state and mixed with white quartz pebbles, formed, later, a sort of conglomerate, and which now resembles a porphyry as we find it along the base of the Wasatch Mountains.

In those ancient times, what is now known as the west range of mountains, or Brigham range, was an island in this fresh-water lake. The tremendous precipitations and extreme humidity nourished a dense growth of timber and vegetation on the surrounding ranges where now there is only sterility. Mountain floods carried down into the lake immense quantities of timber that soon settled water-logged at the bottom of the lake, and which now, hundreds of feet below the present bottom of this lake, are being converted into coal for the men who are to do business in this old world of ours millions of years hence.

How long this state of things continued on Salt Lake we know not. The geologists of our day give the name of Lake Bonneville to this lake, as it then extended along the foot of the west mountains at Black Rock, southwest of Salt Lake City, and near Hot Springs north of Ogden. We can easily count 13 stages at which the ancient lake stood during the various stages of its existence.

What now constitutes the American Desert, west of Salt Lake, also Cache Valley, Ogden Valley, Utah Valley, Cedar Valley, and Shull and Rush Katties were under the same vast fresh-water lake, and fed by rivers, the very outlines of which disappeared thousands of years ago. We do not know the cause of this rise in the waters of the ancient lake, nor how long they thus stood, nor the cause of their decline, until falling within the present basin line they grew salt as they are today. It is quite certain that at one time the lake was much lower than at present, as we find terraces below the present water surface around the islands and also along the promontory that extends into the lake from the north. It is quite likely that the period which saw the flooding of Great Snake River Valley, with its present fields of lava, saw equally great changes in the Salt, or Bonneville, lake basin. Doubtless at that time were born many of our present chains of mountains, and a new Pacific shore line gave a new climate to our present intermountain country of the West.

The morning of our first day on the lake broke clear and

rosy. We ate breakfast, and lowering our lifeboat, we landed on Fremont Island, then occupied by the late Judge Wenner, a native of the State of Michigan. This gentleman, a lawyer by profession, and then acting as probate judge of Davis County, Utah, chose this lonely island as his abode, on account of lung trouble from which he suffered. His wife and three beautiful children here shared his exile. Sharing their exile these good people had on the island about 5,000 sheep, the profits of which returned a fair revenue to the judge. Leaving the home of this isolated household, we began our exploration of Fremont Island. We found it somewhat of the shape of a crescent, the hollow of the crescent being to the west, and the length of the island about five miles, with a width of scarce a fourth of its length. The formation is micaceous slate resting on quartzite, the quartzite being so rifted and altered by heat as to much resemble porphyry. The slate is filled with microlites, is soft but very tough, and if properly mined could produce excellent roofing slate. The only ill feature it possesses is that much of it contains cubic pittings caused by cubic pyrite it once contained, but which, becoming oxidized near the surface, left the cavities that now exist. On the island we found the one spring made note of early in this article, its waters quite brackish but not unpalatable after continued use. The northern part of the island rises 800 feet above the lake, and at this northerly point there rises a high terrace, which, from the mainland, looks much like an old fortress or castle. At the north end of this high elevation exists the only monument or sign left by the early explorers. It is a cross cut into the face of the rock. It is somewhat oblique, about 8 inches in the upright and 5 inches in the cross-arms. Lieutenant Stansbury discovered it and makes mention of it in his report. Col. Fremont does not, for which reason I am inclined to believe that this cross was made by one of the two Frenchmen who accompanied Fremont to the island in 1843. There is no date accompanying it, nor name nor initials. Were it not made by Fremont's men, then it must have been made by some of the earlier and unknown Spanish explorers. We ascended to the summit of the island, and after taking the altitude and gazing out upon the western part of the lake and its queer looking desolate islands, we returned toward the shore, examining minutely the formation. The measures of slate covering the island contain many veins of white quartz, and thousands of crystals of pyrite altered to limonite protrude from the slate surface and along the beach, and one may pick up thousands of limonite iron pebbles and pebbles of white quartz, formed from broken vein matter, out of the slate. The quartz which abounds in most of the State, in the small islands of Great Salt Lake carries no gold nor silver nor other valuable metal. Very small seams of copper ore appear in places, but not of sufficient promise to warrant working for the metal contained. On the east side of the great cliff, and near where there is a small cave, we discovered a small vein in the metamorphic slate that was what may be termed sal ammoniac in a natural state. Doubtless caustic saline solutions had much to do with its formation.

The entire expression of this barren and desolate little island would indicate at one time great volcanic action, as do also all of the small islands of the lakes. There is a sort of magma found on these islands which I have seen nowhere else on earth. It is made up of a matted slated and in this are imbedded irregular and sharp-shouldered masses of quartz and feldspar. There are immense cliffs of it on this and other small islands, and Hat Island is made up of this matter almost entirely.

A few hours' study of Fremont Island forced the conclusion that the promontory, Fremont Island, and also Antelope Island are a continuation through the lake northward of the Oquirrh, or Brigham, range of mountains. The formation of Antelope Island and the mountains of the promontory are similar and one with that of the Oquirrh range.

The promontory which lies immediately north of Fremont Island is 16 miles long and 6 miles at its greatest width. It is a rough mountain range, rising out of the lake and extending northward toward Snake River. The highest point of the promontory is a little over 7,000 feet above the surface of the Gulf of Mexico. On the eastern slope of the promontory there are several thousand acres of good land, and five springs of excellent fresh water. This land and water are owned at present by ranchmen residing on the promontory. In the cañons of this strange mountain chain there is much mountain maple, cedar, juniper, piñon pine, service berry, and dwarf oak, with excellent bunch grass, with also an immense area of the whole surface covered with artemisia or sage brush. The western slope of this promontory is like the western face of all our mountain chains in Western America, quite abrupt, showing the ragged escarpment made at the time of upheaval; and on this western side the strata forming the whole range are very distinct, consisting of Carboniferous limestone, slate, and quartzite, with an occasional outcrop of syenite at the base. I was most favorably impressed with the mineral indications existing on the promontory range;

silver-lead ores, and copper should exist there in abundance. The copper which I found there occurred as float, but would indicate the existence of very strong veins in the older rock, from which it had been carried by the elements.

On Antelope Island the formation is quite similar to that of the promontory, save that there are more extensive veins of iron ore existing in the slate, and accompanying it there are a few good veins of copper associated with gold and silver. On Antelope Island there are large herds of cattle and horses owned by residents of Salt Lake City, and other herds of cattle pasturing there are owned by people living on the island. There are several large springs of sweet water, excellent soil on the east side, and in the mountain parts of the island we found abundance of piñon pine, cedar, and mountain maple.

On Carrington Island and Stansbury Island there is good grass but no water; as a consequence they are seldom frequented. The smaller islands are utterly barren.

We visited every island of the lake, crossed the promontory, and made measurements of the water depth at different points. The greatest depth found was at a point about 5 miles southwest of Fremont Island, where the water measured just 70 feet, showing that there is at that spot a greater depression than elsewhere in the lake so far as known. Far out from shore the waters of the lake are very clear. At the point where the depth registered 70 feet, we could distinctly see the white bottom, over much of which a spreading marine plant grows in quiet luxury.

The waters of this lake carry in solution from 17 to 21 per cent. salt. It is so much more saturated with salt than the brine of the ocean, that hardly any life exists in its waters, the only exception being a small, semitransparent monster about half an inch long and one-eighth of an inch wide, possessed of most conspicuous and protruding eyes and antennae or forearms that are actively employed in swimming. This little creature is not unlike a crab in appearance, and is the only inhabitant of the briny waters of this lake. It is found swimming in shoals or schools, and it is not present at the same time in all parts of the lake. Neither Fremont nor Stansbury makes mention of these fellows. They are almost transparent and exist in immense numbers. They abound in Great Salt Lake, also in Mono and Owens lakes, in eastern California. Their eyes are conspicuous and the body a jelly-like substance. They are known to science under the name *artemia fertilis*.

The waters feeding Great Salt Lake flow out of Bear River, its largest tributary, also from Box Elder Creek, Willard Creek, Utah Hot Springs, Ogden River, Weber River, several mountain streams that flow from the Wasatch Mountain, in Davis County, the Hot Springs north of Salt Lake City, and also from the waters of Jordan River, which in turn forms a connecting link between Great Salt Lake and Utah Lake, a fresh-water body that lies 40 miles to the southward, in Utah Valley; and the streams feeding Utah Lake are Provo River, Spring Creek, Pond Creek, Santa Quin Creek, Salt Creek, Spanish Fork, and American Fork Rivers. All the above streams flow down from the great Wasatch range of mountains save Bear River, which drains a country farther east.

During recent years the volume of water flowing directly into Salt Lake from the above streams has materially lessened on account of the vast volume of water used from these streams for irrigation of lands of Utah and Salt Lake Valleys. Many argue that the waters of the lake for the above cause have receded from the shore lines of early settlement times. This, however, is a mistaken belief. The area now covered by the waters of the lake differs very little from the area which they covered in 1849, when Lieutenant Stansbury made his survey. It is quite true that there seems to be periods of increase and decrease of the lake's volume, the true causes of which we do not yet understand; but there is comparatively no change in the average year's volume of water present.

It has been said, by many, that there is a subterranean discharge from the lake. This is also an error. Evaporation, which is great in the arid region of Utah, accounts for all of the water that disappears from this great lake.

In our own times this lake is yearly receiving new volumes of salt from many springs that flow into it, some of which are situated as far south as Salt Creek Cañon, in Juab County, almost 100 miles away. The waters of these distant springs flow first into Utah Lake, and although the volume of salt is not sufficiently great to be easily perceived by drinking the water of Utah Lake, yet it is there in solution, and with the discharge of Utah Lake into Salt Lake this salt ultimately finds its way into the latter great salt-sea reservoir.

As to the cubic measurement of salt contained in the lake at present, allowing it to be 20 per cent., the volume of water and the average depth of the lake to be 13.75 feet, and the area of the water surface to be 2,100 square miles, were the waters of the lake to be evaporated there would remain about 2½ feet of good pure white salt over this vast area of 2,100 square miles.

Allowing 332 pounds for each square foot of the vast area of 2,100 square miles, gives us an idea of the vast volume of salt existing in this lake.

For 30 years large quantities of aerated, or air-dried, salt have been gathered along the east, south, and southwest shores. Hundreds of thousands of tons of this salt have been shipped into Nevada, Montana, Idaho, and various parts of Utah, for use in the treatment of silver ores. Immense quantities are used for household use in the Western States and Territories, and also as stock salt. Analysis of the waters of Salt Lake, made by Captain Fremont in the year 1843, gave 14 pints of fine salt from 5 gallons of the salt brine, and the analysis of the salt so obtained gave as follows:

	Per Cent.
Sodium chloride, or common salt	97.80
Calcium chloride	0.61
Magnesium chloride	0.24
Soda sulphate	0.23
Lime sulphate	1.12
	100.00

The analysis of today differs very little from that made by Captain Fremont over 50 years ago.

I have diverted the attention of the reader from the events and cause of our voyage of discovery on Salt Lake, in the year 1891, in order to depict the main and most interesting features of the most interesting body of water. To resume the records of that voyage, I will state that we were engaged for nine days making the voyage around the lake, during which time we encountered most terrific squalls and protracted wind storms, proving that even in summer Salt Lake is subjected to wild and dangerous storms, thus necessitating the use of strong and good sailing vessels by those who desire making the voyage. The student is well repaid for the toil incurred in that achievement. Strange to relate, although our vessel, the *Argo*, often stood on her beam ends during the storms we encountered, and we rocked for hours, yet even those who had never been a day at sea did not experience seasickness during the voyage.

The results of our voyage were some hundreds of plants, some scores of beetles, butterflies, lizards, horned toads, and about a ton of the various rock formations of the different islands and the northern promontory. In looking back to the events of that voyage, it remains a milestone in my life and an event not to be soon forgotten.

During the past 10 years several noted bathing resorts have been established on the shores of the lake, the chief of which are Garfield Beach and Salt Air. Neither money nor pains have been spared to render these places attractive, and a very large patronage is given them during the summer months, being reached by railway lines and within a few minutes' ride of Salt Lake and Ogden cities. They who come to Utah during the bathing season usually visit them. Bathing in this water is most extremely invigorating. There is a buoyancy about the water that sustains the body without effort, and those who once use its waters never fail to visit them again. These waters are said to be excellent for somnambulism and a cure for many nervous disorders. There is one feature highly necessary in bathing in this lake. Woe be unto her or him, while bathing in these waters, who should be far from the shore or vessel when overtaken by a squall. The caustic nature of the brine is such as to blind, temporarily, the eyes, and if the water reaches the throat and nostrils, strangulation is almost certain to be the result. Few deaths, however, have been recorded in this way, as caution is usually observed. Where persons are thus drowned, and the bodies are washed out into the lake, they are carried into deep water, and, reaching the shore of some of the desolate islands, usually mummify in a few months, if not found soon after death.

The time is not far distant when Great Salt Lake will be made the scene of extensive manufacturing works. At either Salt Lake or Ogden the manufacture of caustic soda, chlorine gas, and the various alkalies that are entering so largely into our industrial requirements every year, and every year increasing, may be prepared in immense quantities from this salt brine. The volume of salt present in the lake is practically inexhaustible. Ten thousand years will not exhaust the quantity available, and the ease with which it may be obtained places the cost of salt production at less than \$1 per ton, when gathered into piles along the lake shore. Of late years the Inland Salt Co. has handled most of the salt taken from the lake, and the dairy and domestic salt so prepared is unsurpassed by any salt produced elsewhere in America. During the summer of 1899 there was a salt palace exposition held in Salt Lake City. The palace or building constructed for this purpose was very beautifully prepared. In keeping with its mission, crystallized salt largely entered into its decorations, and in this structure the genesis of Great Salt Lake and its possibilities were pretty well represented.

The climatic influences of the extensive salt-water surface of this lake are such as to render the region of Central Utah one

blessed with a delightful climate. In summer it moderates the heat and in winter softens the wild winds that blow across it. No ice forms on the lake in winter, and in summer its waters are sufficiently cool to temper the winds that flow across them from the hot deserts to the west and southwest of the lake. There are no groves of timber at any point along the lake shore, but on the eastern sides of its desolate islands enough driftwood may be found for fuel to meet the demand of the occasional visitor who seeks these shores. Such driftwood is washed down the waters of Weber, Bear, and Jordan rivers during seasons of freshets, in the months of May, June, and July.

THE PREVENTION OF LEAKS

At Mines—The Importance of System and Attention to the Little Things.

Written for MINES AND MINERALS, by L. C. Morganroth.

One of the greatest assistants to a foreman in combating leaks at his plant is through a properly prepared cost sheet. When he can see, through a clear and concise statement, where his various supplies are going and what they cost; what each department of the plant has cost to operate for the month, with a chance to compare it with previous months, he is 50 per cent. better prepared to combat the little extravagances. The pride in keeping down his expenditures develops those qualities which have rendered the men in charge of the various plants so resourceful and intelligent.

A man employed in cleaning the safety lamps in use at a very gassy mine had a neat little device to assist him in his work. His office was heated with steam from the boiler plant, and a small piece of pipe had been connected to one of the coils and led to a window, extending a few inches outside. The end of the pipe was provided with a nozzle giving him a steam blast to clean gauzes. By means of a lever he could shift a small wheel in front of the blast, which, revolving, caused his brushes used in putting the finishing touches to the cleaning to rotate. These little devices enabled him to do one-half again as much work as if performed entirely by hand. At the same colliery, the cars were delivered to the breaker by means of a tail-rope system. The rope attached to the front end of the trip was connected by a simple, ingenious device which automatically released the rope when the trip reached a certain point. By means of this the services of one man were dispensed with. The mine cars in use were slightly modified, only slight changes, yet lengthening the life of the car considerably. A neat little device was in use by which the hoisting ropes could be tarred while running. The foreman in charge had evidently had some experience with breaker fires, judging by the means he had adopted to combat it at this plant. Fire plugs were scattered at convenient points around the entire plant, with coils of hose conveniently arranged to be attached in the shortest possible time. Inside the breaker, short pieces of hose were directly connected to the pipe line, through which the breaker pump forced the water used in washing the coal. Every point of the breaker was commanded by at least one of these hose. It required but the turning of a single valve to have a stream of water on. At numerous convenient points, barrels painted a conspicuous white were scattered and kept constantly full of water. Immediately above each barrel hung two fire buckets, while in a rack were three or four hand grenades. A regular fire drill was indulged in at least once a month, and a regular inspection of all the apparatus was made once a week, a report being made and filed of the same.

A busy mechanic in a mine, among whose manifold duties was included the running of a small pump, fixes up an alarm to notify him, when away from the pump house, when the sump is full or empty. It is only a discarded engine whistle, with a few crude repairs, connected by means of a small pipe to the main steam line. The whistle lever, by means of a rope or wire, is connected to a float in the sump. The latter rising and falling with the level of the water, causes the whistle to blow when it is either necessary to start or stop the pump, a few crude levers and pulleys transmitting the movement of the float in the proper direction and with the requisite amount of leverage to blow the whistle. In case the sump becomes empty during his absence, the steam is automatically shut off from the pump. It is not altogether the neatest looking affair, yet efficient and made from what material and with the tools he had at hand.

At a boiler house at this colliery, where mechanical blast had been substituted for the customary steam blower, the increased amount of clinker formed, with the increased difficulty in detaching it from the grate bars (generally the result of the dry air blast), was obviated by admitting a little steam to the fan used in furnishing the blast. A small pipe led from the exhaust of the

engine used in running the fan, to the fan. By means of a valve the requisite amount of steam could be controlled. Thus, all the advantages of the air blast was obtained without the corresponding disadvantage of the increase in the amount of clinker formed. This was a device of the boiler man in charge—a level-headed but illiterate man. He could not read, and consequently saw no technical journals. It was merely the outcome of his own shrewd observations and experiments. It is not presented as the original idea, but it was original with him. He had also constructed a neat little arrangement to automatically admit and shut off cold water to his feedwater heater.

One of the most prolific sources of waste formerly at a colliery, and is often yet, was in the use of oil. The extravagance in this one article was enormous, often 100 per cent. more being wasted than used. Oil, when but a drop or two was needed, got 50 or 100 poured on, the machinery generally being oiled by a boy, with all a boy's irregularity and carelessness in attending the same—now swimming in oil and then absolutely dry. Isolated fans and pump houses had a barrel of oil handed them, and the head was knocked in and the oil thrown at the machinery with a tin cup. Mine cars were considered sufficiently oiled when a well defined line of grease extended from the oiling stand to the tippie or the mines or both ways; while frequently the spokes, axles, and body of the car were well oiled, for various reasons. One-half of the oil wasted was due to the poorly constructed oiling devices used on the wheels, possibly oiled through a hole or two, located at convenient points on the hub, and which are supposed to be kept closed by a cap either closing with a spring or screwing in; all right for a time, until the mine dirt clogs up or cuts the threads, or the springs break or are lost; then the cap refuses to work, is lost or deliberately thrown away. Consequently, on each revolution of the wheel two or three little spurts of oil, depending on the number of these oil holes, lubricate the ties on either side of the rail as long as there is any oil to run out. But lately the writer saw a plant where the cars on leaving the mine ran on a trestle where they were oiled. This trestle was one mass of oil. It must have been positively dangerous to drop a lighted match on it. A mixture of pasty oil and dirt formed a ridge along each rail, as high as the rail itself, and on both sides of it. Underneath the trestle two regular little mounds extended the entire length of the trestle. Barrels of oil must have been wasted here annually. Of late, car wheels are being improved by which this source of waste is reduced, several good ones being on the market at present. But the general waste of oil can only be obviated by getting its distribution down to a system. Such is now becoming the general practice. No more scattering oil around in barrels, at convenient points, where it can be gotten at by anybody, at any time. Now all oil is given out at a central station. It has been determined exactly how much oil is required for each and every piece of machinery about the plant, and the man in charge of each machine is furnished with an exact amount, which must last him a stated time. It is ample enough to oil all the bearings, but absolutely none is allowed for waste. The same in oiling the mine cars. The oiler has sufficient to oil his cars, but no extra amount to decorate the sides of the cars with frescoes. The runner of the mine locomotive cannot leave his engine standing idle for an hour or two and his cylinder lubricators open to feed oil in cylinders that are not working. It is surprising how much a man can save when he has to. There is no skimping in the supply, but there is absolutely no allowance for waste, and consequently there is no waste, every one being held responsible for his own machinery. With the amount of oil for the same having been determined by careful and conscientious tests, by an expert, he has no excuse to offer if his supply of oil does not last him the allotted time.

The improvement in all machinery used about the collieries is noticeable. The boiler plants are most modern. Automatic stokers, improved grates, diffused air blasts, ash and coal conveyors, cause the boiler plant to be run as economically as if situated a thousand miles away from the nearest mines. While every improvement in machinery in a general way is toward cutting down the expense and waste incidental to its use, there are still numerous ways by which the leaks can still continue, and are only to be reached and remedied by the man in direct charge—the man with the eye to see and the ingenuity to remedy.

At the last meeting of the American Society of Mechanical Engineers, the veteran engine builder, Mr. Charles T. Porter, in his discussion of Dr. Thurston's paper on "The Steam Engine in the Close of the Nineteenth Century," stated that it is a principle of the New Engineering that "the boiler furnace shall be independent of natural draft, effectually consuming its smoke, and burning two or more times as much coal per square foot of grate as it could do under natural draft alone, and yet sending off the gases at a low temperature; the boiler being a steam generator, a superheater, and a fuel economizer combined."

GOLD DREDGING

In British Columbia—A Description of the Dredging Plants and Methods of Operation Used on the Fraser River.

Written for MINES AND MINERALS, by R. Luid Watson.

Gold dredging was inaugurated in New Zealand in 1868. The first dredge, though crude, served its purpose, for from it has been evolved the modern dredge with all its latest improvements.

In British Columbia, within the last 12 or 15 years, several attempts have been made at dredging in the Fraser River. All were failures, with the exception of one at Boston Bar, three miles below North Bend, built in the fall of 1897.

The earlier dredges were designed to work either by "suction" or "endless chain with buckets." Both types were unsuccessful, because of the nature of the bed of the Fraser, composed as it is of large boulders and cement.

The suction dredge, worked by means of a centrifugal pump, was expected to draw or suck up material from the bed of the river and deposit it in sluice boxes, where it could be washed and the gold separated from the gravel. But trial proved that suction could make no impression on the cement. The attempt to have a diver go down to loosen the cement also ended in failure.

The "endless chain with buckets" type was unsuccessful, because the machinery was too light, and the buckets were not of such a shape as could cut into the cement.

The '97 dredge, built by Beatty & Co., of Welland, Ont., is of the "dipper" type.

The plant rests on two scows, each of which draws about 2½ feet of water. On one is erected the machinery, consisting of a 75-horsepower engine, boiler, pump with a discharge of 500 gallons per minute, the arm that works the dipper and the dipper itself; on the other scow, anchored alongside of the first, is constructed the grizzly, across which extends a water pipe connecting with the pump before mentioned; below the grizzly are the sluice boxes.

The grizzly is composed of iron bars laid about 1 inch apart. Into it the dipper discharges its load. The finer material at once passes through the grizzly into the sluice boxes, washed down by the water coming through the holes of the perforated water pipe. Large boulders and the heavier gravel are carefully washed by a man stationed at the grizzly, who throws the worthless material into the river.

The entire string of sluice boxes is 120 feet long, the first 30 or 40 feet being 3 feet wide, the balance 6 feet wide—in the latter part mercury is used.

The dipper is constructed of cast iron with a steel lip protected by steel prongs necessary to penetrate the cement. It has a capacity for raising 1 cubic yard of gravel each trip, and can make two trips in three minutes. The dredge works to a depth of 25 feet. Most of the gold is found in the cement adhering to large boulders. The scow on which the machinery is built, has house room for the crew during the season. The length of season depends upon the state of the water and the winter. Very high water or the running of ice prevents working. In case of ice, a hole is made in the bank and into it the scows are run.

This dredge has been successful; but it has been working the greater part of the time on Boston Bar—composed to a large extent of loose sand and gravel—only a comparatively small proportion of the time has it operated on the cement.

The latest dredge constructed on the Fraser River is near Lytton. Its machinery is designed after the most modern of New Zealand dredges, and was manufactured by Robey & Son, of Lincoln England.

Some idea of the massiveness of the plant may be gathered

from the illustration, and by considering the fact that the total weight of the dredge housed in—excluding the weight of the tailings elevator, but including all gold-saving devices—exceeds 400 tons.

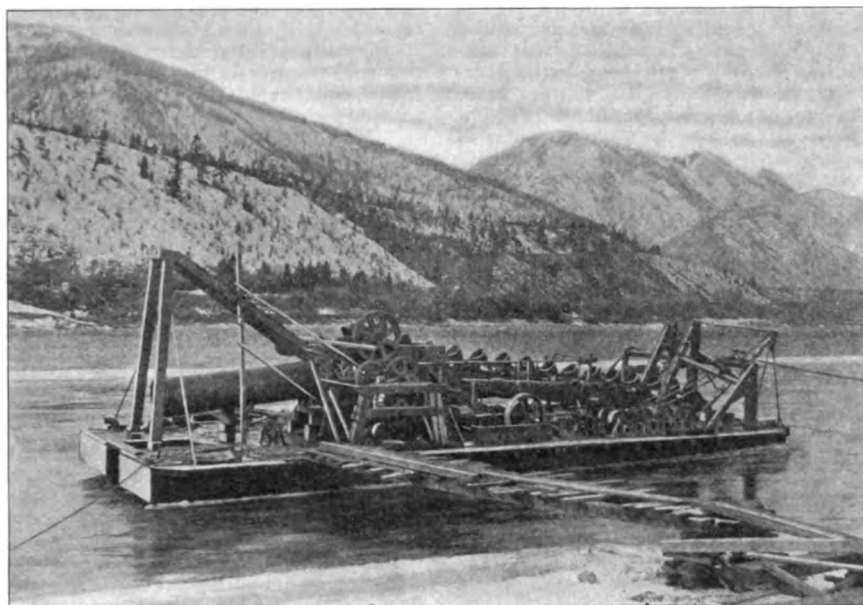
The boilers have a capacity to generate steam of 250 horsepower. 125 horsepower is required to revolve the buckets which scrape the bottom of the river and bring up the material from which the gold is to be saved; the balance of the power is required to run electric motors connected with the pump and the revolving screen, and will furnish power to run the tailings elevator.

The winches shown on the right-hand side of the illustration are four in number, and controlled by levers so arranged that one man can handle the entire machinery on the starboard side of the dredge boat; another man is required on the port side to attend to the boilers and engines.

The principle upon which this dredge is designed is similar to the endless chain with buckets. Two of the buckets with the two links connecting them weigh 2,100 pounds, empty, and have a capacity of raising 5 cubic feet of material in each bucket. There are 36 of these buckets connected by heavy links, the whole revolving at whatever rate of speed is deemed advisable when the material the dredge is working in is taken into consideration. A study of the illustration showing the machinery in place reveals the string of buckets as they are traveling along the ladder towards the large cog wheel, at which point each bucket is automatically dumped. After discharging its load the bucket passes down into the river and resumes its scooping operations.

So minutely is all the machinery adjusted that whenever a

bucket in running along the bed comes in contact with any specially large boulder or material which offers resistance, the man attending to the winches can tell in an instant that something is wrong, and by a movement can stop the machinery, and by another movement can swing the line of buckets to right or left of the point of resistance, by which means—in case of resistance being offered by a large boulder—an extra deep hole is cut out and the boulder allowed to topple over into the excavation; or, if this cannot be accomplished, by reason of the boulders being too firmly embedded or too large, another movement of the lever would lift the string



DREDGE OPERATING NEAR LYTTON, B. C.

of buckets passing along the bed entirely over the obstacle, and at the same time another lever could be used which would tighten the head lines by which the dredge is secured to the banks of the river, thus working the dredge forward so that with another revolution the line of buckets would be clear of the obstacle.

A bucket is manufactured in three pieces: the bottom, or base, is of cast iron of the toughest description, charcoal Swedish or Scotch pig iron would probably be best adapted for the purpose; attached to the base is a steel side; to the side is attached a lip of hardest steel manufactured, which, it is estimated, will be sufficiently hard to cut into any description of cement found composing the bed rock of the channel.

The depth to which dredging operations can be carried on is regulated by the addition or subtraction of one or more buckets from the chain. It is estimated that the greatest depth to which it can work satisfactorily is 40 feet.

Material hoisted in the buckets is dumped into a revolving screen made of boiler iron punched with holes ¼ inch in diameter. The screen is 20 feet long; through its entire length extends a water pipe connected with the pump, which has a capacity of raising and discharging 2,400 gallons of water per minute. Of course the water pipe is stationary. As the screen revolves around it, water is discharged from numerous holes, not only thoroughly washing the material dumped from the buckets but, by the pressure exerted, tearing the cement to pieces, and thus aiding the revolving screen. Since all material which enters at one end of

the screen has to travel about 150 feet before reaching the discharge end, it can readily be understood that the working of the screen added to the pressure of the water will have a crushing capacity sufficient to grind the gravel to such a degree of fineness as to release all the free gold from the quartz matrix and permit it to pass through holes in the screen onto tables. The tables are arranged under the screen with a slight inclination; on them the heavier particles of gold are saved, while the lighter particles and waste or sand pass over the tables into the sluice, which is at right angles to the tables and extends beyond the end of the dredge a sufficient distance to save all the gold. The method of catching the gold on the tables is gravity—the tables are covered by wire netting to act as riffles. Mercury is used in the sluice box to save the finer gold.

The tailings consisting of gravel and sand too large to pass through the perforations in the screen, proceed to the elevator. This tailings elevator is not shown in the figure because it had not been installed at the time the picture was taken, but the framework for it is shown above the screen. The elevator is so arranged that the tailings are dumped at some distance from the side of the dredge instead of immediately in the rear. Such a method of dumping permits of the dredge being backed from the location of its working, which could not be done if the dumping were immediately astern of the plant.

By the discharge of so much material and water from the screen it would at first sight appear impossible for any substance, however high its specific gravity, to remain on the tables under the screen. It must be remembered though, that the screen is about 4 feet in diameter, and that although an immense amount of material and water is discharged into it during 24 hours, yet the holes, being only $\frac{1}{4}$ inch in diameter, permit but a small proportion of either water or material to pass onto the tables. It is estimated that little outside of gold and black sand, with their proportion of water, will find its way through the holes to be received by the tables. The balance of the material and water is discharged into the tailings elevator. The area of the series of tables is 20 ft. $\times$ 22 ft.

Only one feature of this dredge calls for adverse criticism, viz., the direct dumping of the buckets into the screen. While this course will work satisfactorily in sand or small-sized gravel, when you come to consider the problem of hoisting a large amount of material consisting of boulders weighing from 100 to 500 pounds, it would seem that dumping such material into the screen directly from the buckets would make the wear and tear of the revolving screen so excessive as to seriously interfere with profitable results.

Of course this difficulty might be overcome by stationing a man at the bow to remove any materials from the buckets revolving from the river, which he considered too large or too heavy to be dumped into the screen. The adoption of such a course would tend to depreciate the capacity of the dredge, and, consequently, make operations more expensive and results less satisfactory.

Had a grizzly been constructed to receive the material directly from the buckets and to automatically dump all material too large to pass between the bars of the grizzly into the river, thus allowing only comparatively light material to pass into the screen, then, according to our judgment, this dredge would apparently be as nearly perfect as it is possible to construct such machinery.

The valleys of the Fraser and Thompson rivers were apparently excavated at the close of the Miocene period. During the glacial period that followed, these valleys were filled with boulder clay. In the postglacial and modern periods, when the country stood at its present level relatively to the sea, rivers cut through the drift-filling, and, swerving from side to side, produced a series of terraces or benches. These terraces, thus represent the bed of the river at a former stage in its history.

In '57, '58, and '59, when placer mining in the Fraser and Thompson rivers was at its height, fully \$1,500,000 worth of gold was washed from the beds and benches with the rocker and by sluicing. The pay streak in the benches was found near the surface, the general mass of material composing the terraces was not payable worked by such rough methods. What was not profitable worked by primitive means might easily yield good results to more improved methods. Terrace materials especially in the vicinity of the mouth of a stream flowing from a known auriferous locality would justify test operations. But the present dredging law in British Columbia precludes such from being worked by the dredge miner. For, according to it, a lease gives the right to work in a river only below low-water mark.

In New Zealand, alluvial deposits extend into the banks for acres, and miners are allowed to work the banks as far as they find them profitable.

True bed rock is seldom seen in the Fraser River. In most places the bottom of the old valley is below the present river level.

The formation at Boston Bar is of a slaty and schistose

character closely resembling the Cambrian, but probably of later date. Similar rocks occur at Leech River, Vancouver Island. In each case the slates contain gold-bearing quartz veins. To the degradation of large areas of these slates, the placer gold is probably due.

The present law for dredge mining in British Columbia is drawn so as to protect the placer mining along the banks of the various streams. According to this law a lease conveys the privilege of working material in the bed of a stream from bank to bank, below low-water mark.

Leases are granted by the government at \$10 per mile; and five miles of a river bed may be taken up by a lessee each year. Lessees must enter into a contract to expend not less than \$1,000 per year on the territory occupied by each lease. These lessees must be either miners or joint stock companies holding a free miner's license. Every person over 18 years, regardless of nationality, is entitled to a free miner's license on the payment of \$5 per annum.

Up to the present, dredging in British Columbia has been almost entirely confined to the Fraser River. The yield of placer gold from portions of the Thompson, North Thompson, Columbia, and other rivers on the mainland, as well as from Leech and Sooke rivers, on Vancouver Island, will probably attract the attention of dredging miners to the advisability of prospecting the beds of these streams to ascertain whether the conditions are favorable for dredging. In the foregoing estimate of likely localities, no mention has been made of the more northerly section of the Province, including the Cassiar, Omineca, and Atlin mining districts. So far as we know, no attempts have been made to discover whether the streams in these districts are favorable to this mode of mining.

Undoubtedly, if the companies which are at present using this method of winning gold from the bed of the Fraser demonstrate that the business is profitable there will be no lack of others to embark on a like enterprise.

Considering that there is hardly a river in British Columbia which does not show colors of gold, the field for the industry appears large. The time is not far distant, we may assure ourselves, when dredge mining will be one of the most profitable industries of the Province.

TRANSPORTATION ON INCLINES.

Methods of Getting Coal Down the Mountain From Mine to Tiptle in West Virginia.

Written for MINES AND MINERALS, by Edward H. Cox, C. E.

One of the first questions which confronts the coal operator who contemplates opening a mine in certain portions of West Virginia, is what method he had best adopt to get his coal from the mine up in the mountain down to his tiptle in the valley. Of course the question of power does not enter into the problem, as the weight of the loaded cars going down brings the empties back.

These inclines are laid usually double track or three rail with a passing switch at the middle. Of course the former makes the first cost higher but gives the advantage of a straight track from top to bottom, which is of course, better, making less liability of cars getting off the track.

The next consideration is whether to use drums or sheave wheels, what kind, and their location.

The drums are located at the top of the incline, and usually directly above or below the track, and are of two kinds, straight and geared. The former consists of one drum with one rope winding on from above and one from below, and should have a brake band on each and operated by separate levers, the second one to be used in emergency only, in case the other one breaks. The latter consists of two drums geared, one being set ahead of the other.

With this style of drum both ropes wind on the same way, which under some circumstances is a great advantage, the drums turning in opposite directions.

For a long incline, making speed an essential consideration, the drums should be of large diameter, 10 or 12 feet. These drums should be lined on the outside with wood, as it is easier on the rope than iron, but at the same time it should be well seasoned hard wood so as not to shrink after being put on, and so the rope will not cut into it.

If sheave wheels are used, they may be either single or double. If single, there is a spiral groove passing around the wheel allowing the rope to make three or four turns, and the friction of the rope on the wheel controls the rope when the brake is applied. The single wheel may be either horizontal or vertical or inclined.

If double sheave wheels are used the rope passes around both

in the shape of the figure 8, in some instances making three or four laps, sometimes only one. These may be set on line with the incline or off to one side, the rope passing around a sheave wheel on line with the incline. The sheave system has the advantage of being cheaper in itself and requiring less rope and less space than the drum, but it is much harder on the rope for the reason that when the brake is applied there is a tendency for the rope to slip on the sheaves, causing wear. The sheave is also open to the objection that in wet, snowy, or icy weather, the rope sometimes slips so badly as to be beyond control, or making it necessary to sand the rope or sheaves. The drum also has the advantage that although it requires more rope, if a few extra laps of each rope are left on the drum it allows of cutting some of the lower end of each rope as it wears out, the lower end always wearing out the faster.

The next consideration is whether to use a monitor or to run the loaded mine cars down the hill, and if the latter, how many to the trip, and whether to use a chain and coupling or to use a barney, sometimes called a dummy or bull. The monitor is an iron car of 6 or 8 tons capacity, and is uncoupled neither at the top nor bottom. When it is used, the mine cars are dumped into a large bin at the top of the incline, and the monitor is loaded under this bin and is dumped into the railroad car at the bottom of the incline. This has the advantage of avoiding coupling and uncoupling but possesses the disadvantage of necessitating dumping the coal twice, which of course causes more breakage than if only dumped once. If the miner is paid by weight, the coal must be weighed at the top before it is dumped into the monitor.

If the chain and coupling are used, the cars are coupled to the rope at the top, and if the incline is short, not over 200 or 300 feet, one car is usually let down at a time, and this is sometimes dumped without uncoupling, which is, under most circumstances, an advantage. If, however, the incline is long, time is saved by running two or three cars to the trip and uncoupling at the bottom, having an extra trip on the tippie which will be ready to couple to as soon as the trip lands.

If the barney is used, it does away with coupling at both top and bottom, as the barney runs in front of the cars going down, on a narrower track, thus holding them back, and at the bottom runs into a pit, allowing the mine cars to pass over it, and the empty car or cars are then pushed over the barney hole and the barney pulls them up the hill from behind.

The writer does not advocate the use of barneys on a steep incline or one with a sharp incline at the bottom, as there is so much liability of empty cars getting off the track and if they do they are very liable to turn around and slide back down, as they are pushed from behind by the barney and not coupled to it or the rope. The use of the barney requires a double track from top to bottom, and unless the barney with adjustable double-grooved wheels is used, it requires an extra double track for the barney, but with the adjustable wheels it requires only a short piece of barney track at the bottom, so that the first cost of equipment is higher for barneys.

Each of these methods has its advantages and disadvantages, and the writer does not advocate any particular one, as it usually depends on natural conditions and the details of the results desired which will fill the bill the best.

One thing, however, that is desirable is to have the incline of uniform grade or tending to a concave, as under these circumstances there is much less wear on the cable and the trip is always in sight of the drum runner. Every hump or knuckle in the track hides the trip from the drum runner's view, and makes the rollers at such places hard to keep in place and in shape on account of the pressure on them, and hence makes more wear on the rope.

Another system in use in a few places, and destined, the writer believes, to be used much more where the grade is steep enough, but not too steep, is a long chute from top to bottom into which the mine cars are dumped at the top, and which is dumped directly into the railroad cars at the bottom. About 30° from horizontal is a very good grade for a chute for most coals. If the coal runs too fast, heavy check doors hinged at the top can be placed in the chute at intervals. This system has the advantage, that if there are no railroad cars at the mine the chute can be filled up and the cars loaded from it when they get there.

On account of the annoyance from rats about many mine barns, particularly underground, the following from *Electricity*, New York, is of interest: "When I was in Chicago for a few weeks last summer," said a well known electrical engineer, recently, "the office building I was in was infested with rats. At my suggestion the owner of the premises placed two electric wires of opposite polarity across the rat holes in the basement in such a position that a rat must touch both in coming out. Some were shocked, but most of them were killed, and the place was soon entirely free from the pests."

WELSH COKE OVENS.

A Description of a Form of Oven Used in West Virginia in Place of Beehive Ovens.

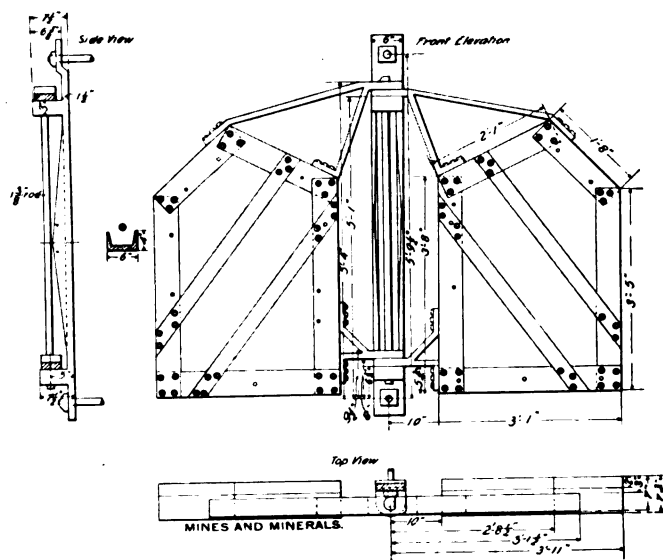
The beehive coke oven is in such general use that the other forms, excepting the by-product types, are usually lost sight of and they are seldom mentioned.

It is probably not known even to many coke producers that the Welsh type of oven is used at a number of plants in West Virginia. This is an old form of oven which was originally designed to reduce the cost of coke drawing from the beehive oven by the substitution of a mechanical drawer for hand drawing.

The oven consists of an arched chamber, rectangular in shape, having one end walled up and the other or front end closed by doors or by a wall of luted firebrick. The gases escape by a chimney located at the rear end of the oven.

A characteristic feature of these ovens is the drag for drawing the coke from the oven. This consists of an iron bar laid on the oven bottom, and having a cross end-piece at its inner end. The charge of coal is laid on top of the drag, and after the coking has been finished it is drawn out by a windlass or by an engine.

The modification of the Welsh oven as used at the Red Ash Mines, West Virginia, has been described for MINES AND MINERALS by Mr. F. Howald, E. M., general manager of the Red Ash Coal Co., as follows: Our plant consists of 80 Welsh coke ovens. They are rectangular in shape, 15 feet deep in the clear, 6 feet wide at back,



and 6 feet 4 inches wide at front. They are arched with a cylindrical arch of 42-inch radius, 12-inch arch brick being used. From the floor at front to spring of arch, distance is 48 inches, and to crown of arch the height is 5 feet 10 inches. Floor is laid with 12" x 12" x 4" blocks, and is 4 inches lower at front than at back. The division walls between ovens are 27 inches at back and 23 inches at front. Center of charging hole is 8 feet 11 inches from front. The products of combustion pass through openings in the back wall either into flue or into short chimneys. At the front the opening of oven is reduced to a height of 4 feet 8 inches by an arch of 4' 10" radius laid up with arch brick 16 inches deep and 12 inches wide. Over this front arch, wall is laid up with red brick to hold filling over ovens. The opening of oven is closed with double doors hinged at center of division wall. The doors are made of firebrick blocks 6 inches thick bolted to angle iron frame. A space is left between the doors for leveling, which is afterwards closed with brick and daubed. The accompanying sketch of right and left door of adjoining ovens shows skeleton of frame and how the doors are hinged.

After an oven is drawn, and before it is again charged, a drag 5 feet long, cut from 60-pound T rail is laid across back of oven. To the drag is attached a drawbar extending to front of oven. The ovens are drawn by means of a $\frac{5}{8}$ -inch wire rope, two blocks, and a grip, the power being supplied by a $\frac{3}{4}$ -inch endless wire rope running along front of coke wharf.

The heat from 40 of these ovens, instead of being wasted, is carried into a firebrick flue of approximately 15 square feet area running back of the ovens, which carries the heat under a 300-horsepower Stirling boiler.

The oven is, of course, a very old type, first used in Wales, and is, I believe, still in use there.

COPPER DEPOSITS

Of the Ajo Basin, Gila Basin, Arizona—The Large Amount of Mineral and Difficulties of Exploiting.

A Description of the Country and Its Facilities in Regard to the Supply of Fuel and Water and Timber Necessary to Operate the Mines in That Region.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

To one visiting for the first time a new or little known region, the charm of novelty is great. People, trees, flowers, birds, and beasts all claim their share of interest. Nor is the sudden change of scene less noticeable than that of climate. A week ago we were hugging a stove in a miner's cabin in the Gunnison Mountains of Colorado, after a tramp knee deep through the snow; today we find ourselves in our shirt sleeves chasing the shadow of a lone tree, or a great rock in the warm deserts of Arizona.

Such was our experience as after a tedious day and night journey we woke up on what seemed a calm spring or summer morning in the month of February, at Gila Bend, in a spacious adobe room, adjoining the stable of the Gila coach which was being hitched up outside to carry us bright and early over the Gila Desert to the Ajo copper basin, some 50 miles distant. We were advised of our semitropical surroundings by a palmetto growing in the yard opposite our window, whilst across the road, over at the railway station, was a garden full of strange cacti, aloes, and yuccas, plants we were to see later on a much larger scale in their native habitat in the Gila Desert.

We were on a flat sandy plain 50 to 100 miles in length and breadth, seemingly encircled by mountains of the wildest and

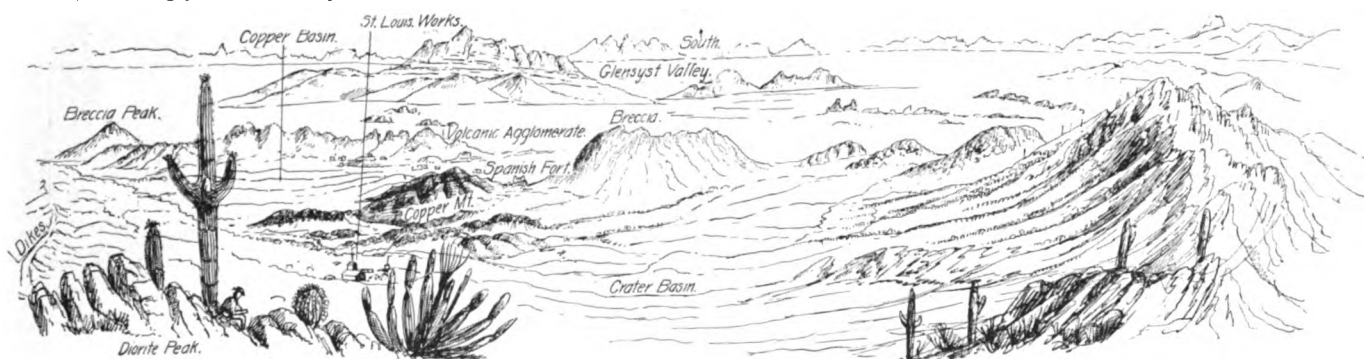
driver informed me, it is dangerous to ride or drive, for fear of the horses stepping on the reptiles.

Of birds we saw few; amongst them that singular long, very thin bird called the road runner, who with his long beak is a formidable enemy to the various reptiles. Flocks of California quail, with their pretty little parasol top knots, are very numerous, and a species of small humming bird swarms among the cactus and other desert flowers.

Despite the general aridity there are evidences of not infrequent very violent rains or cloud bursts which, at certain seasons, turn portions of the country into a sandy, but short-lived lake, and sweep through the dry watercourses with terrific force. The surface water is soon gone and absorbed by the thirsty sand, but by digging a few feet, a well soon discovers a fair amount of water.

We took special notice of these facts, because the water and wood problems are supposed to be the most formidable obstacles in the way of Arizona mining.

Timber and Fuel Facilities.—Along these dry watercourses, or arroyos, is a very peculiar arborescent vegetation. These bush-like trees are unlike any we have seen elsewhere. The commonest and perhaps the most singular is a tree from 15 to 20 feet high, called the "Palo Verde," or green tree, and it is the most emphatically green tree at all seasons of the year we have ever seen. The bark on the trunk which may be 6 inches to a foot or more thick, is as green and smooth as a green apple, or as if it had been fresh painted; the branches and twigs are all of the same tint, and the foliage is of a seaweedy, or plumose character. Like all the vegetation of this desert it is armed with formidable thorns. The wood is soft and is much bored into by woodpeckers and wood-boring worms, which causes it to decay. It makes a fair fuel for mining purposes, and cordwood can be cut off it with diameters from 6 to 10 inches. Besides this is the mesquite tree, a species of Mimosa some 15 to 20 feet high, with trunk 6 to 10 inches diameter, and another tree about the same size, whose



THE AJO CRATER BASIN LOOKING SOUTH FROM DIORITE PEAK.

ruggedest outlines. The plain was evidently the bed of a great lake or sea, extending for hundreds of miles north and west into Northern Arizona and Southern California, about 150 miles distant, of which it was probably once an extension. The mountains, all of them volcanic, though seeming to surround the plain as by an impassable barrier, are in reality more like a collection, or archipelago, of islands, amongst which, by innumerable passages, the "prairie schooner" can sail anywhere at will.

About four miles north of the station, a long line of cottonwoods marks the bending course of the Gila River, one of the few living rivers of this arid zone. Even of this, a large proportion of the water sinks into the sand, and throughout Arizona, often a better river may be found by sinking a few feet below the dry bed than the one that flows in places above that bed.

After breakfast at the Mexican adobe hotel, our coach started southward in the pleasant early morning to the Ajo mines. Now, as we entered the desert the barren adobe ground was strewn with volcanic pebbles, the soil unbaked, parched, and cracked was scantily clothed, not with the usual sage brush, but with a small species of bush Mimosa, of a brownish-green tint, with small yellow flowers, called the mesquite.

At the roots of these bushes, where the soil accumulates and where there may be a little shadow and moisture, numerous small holes are bored, tenanted by small chipmunks, who scamper along with bushy tails erect. Some of these holes are the abodes of rattlesnakes, and others of that strange, sluggish, repulsive looking pink and black lizard known as the Gila monster, whose bite is said to be as deadly as that of the rattlesnake, which often here attains a size of 4 to 6 feet in length.

Over rocks and sand glide tiny, little, swift, harmless lizards, flashing hither and thither like a streak of lightning.

In summer, the heat is so great that even the rattlesnakes do not emerge from their holes till after dark, and then, as my

species we do not know, called an "iron wood," or "mahogany." The wood of these trees is hard and not unlike mahogany or boxwood, and makes a very hot fire. For small work in mining these trees might also be used. These are the main staples of fuel in this otherwise treeless region, and despite their comparatively dwarf size, their abundance makes them a very fair substitute as a fuel for the usual forest trees of more favored and wooded regions.

But by far the most striking and peculiar vegetation is that of the "cactus" family which in this region assumes the most grotesque and extraordinary forms, and attains to the most gigantic proportions. Most remarkable of all is the Suwarrow (saguaro), or giant cactus (*cereus giganteus*). When first we strike the desert we fancy it is dotted over with telegraph poles, until we approach one of them, and find it to be a beautiful fluted column of green cactus fiber, 20 to 30 feet high, and 1 foot to 2 feet in diameter. About two-thirds of the way up the column, or 15 feet from the base, one, two, three or more great horn-like branches start from the trunk, giving the cactus the appearance of a huge candelabra. The tips of these horns as well as the top of the column are at certain seasons crowned with beautiful cream-colored cactus flowers. Passing through groves and colonnades of these extraordinary forms of vegetation, together with those of no less grotesque but humbler shapes, we fancy ourselves back in the old Carboniferous period, among its strange forests of "lepidodendra," gigantic reeds, and mosses. As a young plant (according to the botanist Engelman) 5 or 6 inches high, may be 10 years old, we may form some idea of how old a monster 25 to 50 feet high might be. Some of these are broken and in various stages of decay, showing a curious inner skeleton of long, tough, lath-like fibers, which as they are used both for fuel and for building purposes, or lining of adobe houses by the natives, may also be included amongst the fuel and timber resources of the Gila Desert.

The flowers have a long tube, and are 5 to 6 inches long and 3 to 4 inches diameter. The petals are a light cream color. The fruit is pear-shaped, 3 or 4 inches long. The flowers are open day and night. This cactus belongs to the *Cereus* family, and is called by botanists the *Lepidocereus Giganteus*.

There is another *Cereus* called by the natives Pitahaya pronounced "choya," which is smaller, and has numerous branches thickly covered with yellow spines, at a distance looking like yellow wool. The dead trunk or branch fiber of this shows, when dry, an elegant reticulated pattern.

A very formidable looking cactus about the size of a small barrel is covered with the strongest and most cruelly curved fish-hook spines it is possible to imagine. Its purpose in life seems to be "to have and to hold."

Another singular plant like a lot of tall whiplashes, tipped with tiny red flags, is called the *Ocotilla*, pronounced *Ocatēca*. When overthrown and lying prone on the ground, the numerous long arms all spreading from the same root, remind us forcibly of an octopus, or devil fish. This also in a minor way is used for fuel, in fact, everything that will burn is so used, and most of these plants produce an exceedingly hot fire.

The Indians, in war time, used to make a curious use of the giant cacti. They ignited the fine spines which line the edges of the fluted columns, and in a moment a column of flame and smoke rose to the top and into the sky, and so they signaled to one another.

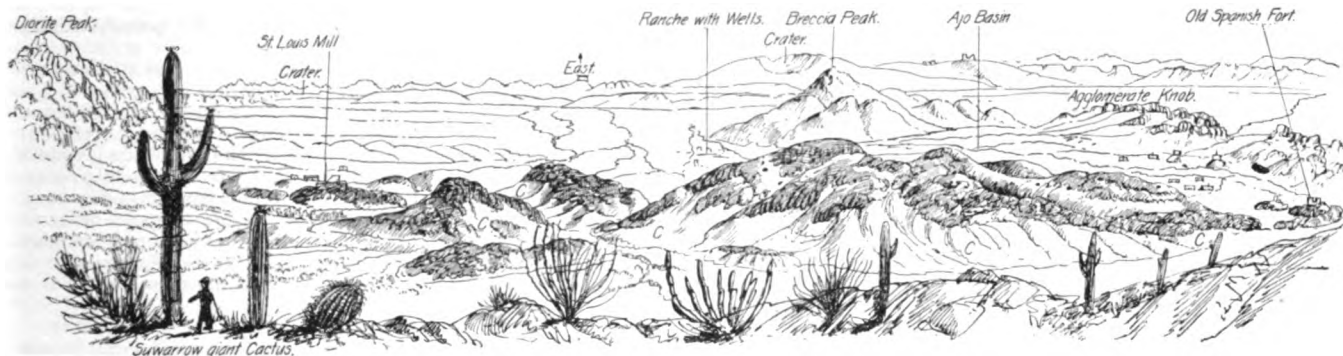
Midway to the Ajo basin we passed through the eroded crater of a big extinct volcano. The walls were of black basaltic rock; the bottom of the crater might be a mile or two in diameter; everywhere great rugged masses of black lava were piled one upon another, giving the place a most wierd, sombre, and inferno-like aspect. High up amongst the black walls, in crevices of the

north end in a very tall peak of mica diorite, a rock much resembling granite; the remainder of the northwest wall appears to be formed of dark basic varieties of diorite, and of diorite breccia. These walls are traversed by narrow dikes of dark diorite having a general easterly direction. Two of these dikes, close together and parallel, must once have formed the northeastern portion of the wall of the crater, which at present is an open gap to the basin, the dikes having been eroded down nearly to the basin level. The eastern wall is composed of diorite breccia, and the southern of an exceedingly coarse volcanic agglomerate; the fragments of rock in this cemented with an adobe sand are often a foot or more in diameter. Right in the center of the basin, and a most conspicuous object especially to the prospector, are two hills about 200 feet high, about 2,000 feet in length, and about 1,000 feet wide at the base. These, from a distance, have a dark rusty-brown color, and nearer, appear here and there heavily stained with bright green carbonate of copper. This mountain is justly named Copper Mt., as we shall have reason to explain later.

On the north end of it, near an arroyo, the works and mines of the St. Louis Co. are established, and at the south end of it, on a little knoll, are the ruins of an old Spanish fort, built to protect a mine close to it as well as a rude smelting furnace, the ruins of which still remain. The walls of these buildings are built of the gay green, blue, and red rocks derived from the copper mines; in these, sometimes occur specimens of native copper, which appear to have attracted the Spaniards and for which they mostly mined.

Tradition has it that the Spaniards were massacred by the Apaches; there are the remains of an old cannon near the spot which seems to have burst in an attempt to fire it.

The flat part of the basin, on the east, has several prospect holes, or young mines on it, which show on the surface a great



THE AJO BASIN COPPER FIELD LOOKING EAST.

rock, towered the lofty fluted columns of the giant cacti, apparently without earth or moisture.

As evening drew on, we approached that most important of all things in the desert, a well of good water, 50 feet deep, yielding about 2,000 gallons daily, around which was a rude cattle corral, built of the gnarled branches and trunks of the desert vegetation. Close to it some Pappago Indians were encamped in their rude "wickups." These Indians do considerable dry placer mining in the dry and sandy arroyos. They dig a hole through the loose gravel down to bed rock and sift the gravel against a rude wire screen, collecting the finer particles in a wooden dish or batea, and winnow off the fine sand with their breath, until the particles of gold appear.

As evening closed in we drove up the dry bed of an arroyo, passing on our way another well much the same as the last, and a small cattle corral. This well, pumped to the surface by a small windmill, yielded about 2,000 gallons daily of good drinking water. A little farther on we passed a long 2-inch pipe, which brings water from a well to the St. Louis Co.'s stamp mill, and is stored in a reservoir, holding 5,000 gallons close to their works.

As darkness drew on we found ourselves entering among the walls of the great Ajo volcanic crater, and no music could be pleasanter to us after our 50 miles lonely desert drive than the dropping of the stamps of the 10-stamp mill, or a pleasanter sight to our weary eyes than the light in the window of Mr. Shotwell's hospitable cabin.

Next morning we were awakened early by the pounding stamps of the mill, and went out to view the basin. For this purpose we climbed a tall hill near the center of it. Ajo basin occupies a much eroded crater of an ancient volcano. The basin may be from two to three miles long by two miles wide. A rudely outlined wall of hills and ridges surrounds it. The bottom of the basin is comparatively flat. The steepest walls are to the northwest, where they rise from 300 to 1,000 feet, culminating on the

deal of green copper carbonate, and with depth, solid bodies of bornite and copper glance. Nearly all these assay high, from 6 to 60 or 70 per cent. copper.

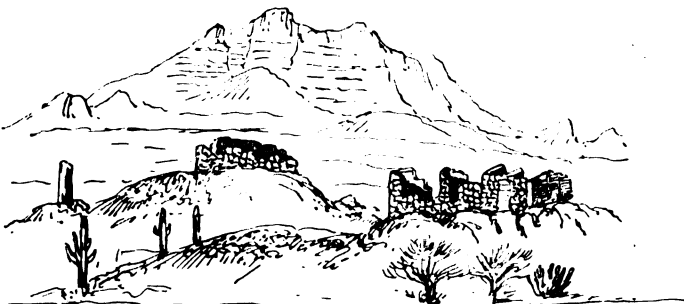
Our interest, as naturally that of any one first entering the basin, was centered on Copper Mt. and its extraordinary oxidized appearance, and we hastened to examine it. We found the country rock composing this mountain to be a species of porphyritic diorite, or porphyrite, composed principally of plagioclase feldspar and crystals of hornblende.

The rock showed generally signs of decomposition; the mountain is traversed in an east and west direction by a series of parallel cleavage planes. Some of these are occupied by narrow quartz veins of lenticular shape.

Along some of the cleavage planes there were strong stains of green carbonate of copper, and open cuts that had been made on these showed rich impregnation of the rock to as great a depth as the cut extended, usually not over 50 feet. Amongst these green stains were streaks of dark copper glance running very high in red copper, also some red oxide of copper or cuprite. In numerous places all over the mountain bright green stains issued from the rocks. But the most remarkable feature appeared when we attempted to make a rough sampling of the mountain. To do this we began to break off small pieces of the brown oxidized rock at intervals of a few feet, when, to our astonishment, we found that every fragment of the rock in every part of the mountain immediately below the veneer of brown oxide showed a strong stain or impregnation of copper carbonate which appeared to descend a few inches at least into the rock. We came to the conclusion that the whole surface of the mountain, from end to end, was impregnated with green carbonate of copper, to what depth we could not tell, but we can give our readers a just idea of the mountain by saying that, in a picture, if we were to paint it all bright Paris green instead of brown, we should only represent it as it really is a few inches below the surface. Below the brown

thin oxidized veneer or skin the general rock from the green stain appears to pass down into a partially oxidized diorite with spots, patches, and grains of copper glance and bornite, with some chalcopyrite.

It would seem as if these metals had in part replaced the dark constituents of the rock such as hornblende. So with depth the ore rock, as that from the St. Louis mine, resembles a decomposed granite, the black minerals instead of hornblende or mica,



OLD SPANISH FORT AND SMELTING WORKS.

being often copper glance or bornite, somewhat as telluride minerals replace the hornblende and mica of the decomposed granite of the Independence mine at Cripple Creek, Colorado.

Copper Mt., taking it as a whole, is certainly the most wonderful impregnation of copper minerals we have ever seen. To what depth this impregnation goes, or what values, or proportion of values with depth form the bulk of this remarkable mountain, it would be premature to form an opinion until deeper developments have been made.

Projected Mode of Development.—The only way to prove up the mountain is to open a tunnel from its base clear through its length of about 2,000 feet from end to end, and if necessary one right across its width of 1,000 feet, and from the center, where these meet, to make an upraise to the surface, and a downcast below it. The longitudinal tunnel N and S would cut through all the east and west transverse cleavage planes, in which we have some reason to expect the main zones of impregnation will be concentrated. A depth of at least 200 feet would also, by this means, be gained under the mountain sufficient to show up the surface character of the hill. As this tunnel would start at water level, it would show above it what the character and values of the oxidized zone are likely to be. To show the nature of the unoxidized or sulphide zone, below water level, the shaft proposed in the center of the mountain will have to be carried down a hundred feet or more.

A remarkable feature of Copper Mt. is its minutely and intensely fractured condition; every foot of diorite is reticulated with minute cracks which are often cemented together by copper solutions. It would seem as if the mountain had been, in this respect, like a huge porous sponge readily penetrated and soaked by the copper solutions ascending from below. Throughout the whole section we could not see anything we could positively call a true fissure in the ordinarily accepted sense, such as a vein of quartz, or vein matter between defined walls.

What were locally called veins, appeared to us to be merely zones of exceptionally strong impregnation, only partially limited or defined by the natural cleavage or joint planes of the country rock.

The probable conditions of the mountain, such as will be revealed by deep exploitation, will, we think, be (1) a thin surface veneer of iron oxide, only a few inches deep. (2) Below this a zone, more or less deep, of copper carbonates mingled with streaks of iron and copper oxide and copper glance and a little bornite. (3) A final zone of bornite and chalcopyrite which will be the permanent condition of the ore with depth.

Lenses of rich ore are liable to occur anywhere. The assays from this basin are no less remarkable than the wonderful extent of the impregnations; they generally run all the way from 3 to 6 to 30 per cent. copper, whilst richer samples will yield 60 and 70 per cent. The assays from the concentrates at the St. Louis mill, on 12 tons concentrated into one, average about 60 per cent. copper, with 1 to 2 ounces gold; and this is from the deepest shaft in the basin, which is not over 100 feet deep.

Mines and Mills.—The developments on the basin may be all called prospects, as there are none much over 100 feet in depth. The principal of these is that of the St. Louis Co. at the north extremity of Copper Mt. Their mine is down about 100 feet; they have passed down through a rich zone of sulphurets and bornite and glance, which continue as impregnations of the rock to the bottom of the shaft, bounded by cleavage planes. In these cleavage planes are narrow lenses of ore of bornite, iron, and

chalcopyrite, rich in copper, averaging 31 per cent. The ore now brought to the surface is a decomposed diorite speckled with bornite and glance. The concentrates run about 65 per cent. copper with 1 to 2 ounces gold. This they concentrate in the adjoining 10-stamp mill.

Mode of Economizing Water.—Both the mine water, which came in a fair stream at 75 feet, yielding about 1,000 gallons daily, and that from a well about half a mile distant, brought to a reservoir near the mine by pipe line, are utilized to drive the 10 stamps, each of which are 900 pounds weight, with two Woodbury tables immediately below them. The water, after passing over the tables, goes into two or three tanks situated just below the mill, each tank having a capacity of 4,500 gallons. In these the tailings settle and pass to waste down the arroyo, and the purified water is pumped up into three similar tanks just above the mill, in one of which is also a condenser, formed of layers of worm-like horizontal pipes condensing the steam from the boiler and engine.

These pipes are cooled by the water pumped up from the tanks below, and that water, together with the condensed steam water, is again returned by pipes to the mill. It is thus seen that the utmost economy is used with that most precious of all elements in this country, viz., water.

The well feeding the reservoir is 2,500 feet distant, located on the bed of a dry arroyo. It is 55 feet deep, and water begins to come in at 25 feet; it yields about 1,000 gallons daily. The water is pumped from the well to the reservoir through a 2-inch pipe. This reservoir has a capacity of 4,500 gallons, which is sufficient to reduce 8 to 10 tons of ore daily.

The water question is the most serious one in this district. There can be little doubt as to the vast quantity of ore of this extraordinary basin. The question is, what to do with it. The superficial investigator who comes in one day and goes out the next is inclined to jump to the conclusion "Lots of copper, but no wood, no water, therefore no good at the present distance from railroads."

But not so fast, my friend. Look around you at that brown haze over the prairie, extending for miles as far as the eye can reach. That is all prairie timber such as I have described, and hundreds and thousands of cords of that wood can be laid down at your mill at from \$2 to \$3 per cord by the Mexicans for at least some years to come, till a railway is built, as seems probable, from Gila Bend to the Gulf of California, over a country for the most part as level as a billiard table, when bigger timber can, if need be, be brought in, and ores, if necessary, be transported out to a suitable place for milling, as at Gila Bend, near the Gila River. So much for the fuel and wood question, now for the water.

I have before alluded to the great underground rivers or underground drainage system of Arizona. At Deming I saw a windmill in every cottage garden, and these all draw ample water for household and irrigation purposes from the arid prairie at a depth of 50 feet.

The whole country, as we have observed, from Gila Bend to Ajo basin, 50 miles, is traversed by a network of seemingly dry arroyos. That these contain moisture below, is shown by the dense growth of Palo Verde and other succulent trees along their courses, and we believe almost everywhere in these a well would find water at a depth not often exceeding 50 feet. These dry arroyos are particularly plentiful in the Ajo crater basin, and



ST. LOUIS COPPER MINE AND STAMP MILL.
T, T, Tanks; W, Woodpile; M, Mine.

every mine that has gone down to 70 or 100 feet has encountered more or less water.

Only two wells have, so far, been sunk in the basin; one on a ranch and the other for the St. Louis reservoir; both of these yield about 2,000 gallons each daily. One of these is sufficient to keep the 10 stamps of the St. Louis mill going 10 hours daily. It appears to us that we have only to multiply wells and to increase the size of reservoirs to supply water sufficient to run stamp mills of 20 stamps or more, 24 hours daily throughout the year.

The extreme porosity of the Ajo basin rock, and the fact that the crater appears to be a sort of sink, or center for the drainage of the immediate region, would argue in favor of the basin holding, below its surface, considerable underground water. At Gila Bend is ample water in the river, both above and below, for a mill of any capacity. Should water or wood fail in time in the Ajo basin, the problem of milling could be solved by a small narrow-gauge line to Gila Bend, by the erection of a large mill there, and by the transportation of the crude ore from the basin.

At present, only the richest ore or concentrates can be transported to the railroad and thence to works for final treatment.

Geology of the Basin and Its Ore Deposits.—The basin appears to be an old and much eroded volcanic crater, one of those old craters of which there seem numbers in this moon-like region.

Erosion may have cut it down nearly to its roots, to the deep laccolitic reservoir from which the main eruptions proceeded, or at any rate to the plug, or stopper, filling the throat of the volcano. The eruption appears to have been at one time more or less explosive, as large portions of its walls are formed of fragmental material, consolidated into a breccia, or into an exceedingly coarse mud-flow agglomerate, such as appears notably at the south end. Later eruptions penetrated the older ones of a more basic variety, as shown by the narrow parallel dikes traversing the northwest wall.

The prevailing rock appears to be of the diorite family with several varieties; some porphyritic, others micaceous like granite, and others resembling andesite and basalt or dolerite.

The central core of the basin represented by Copper Mt. appears to be of porphyritic diorite or porphyrite.

The explosive character of the eruption, or the general earthquake shaking up of the interior of the crater may account for the intensely fractured character of the rock of the Copper Mt. area. The various cleavage planes and so-called fissure veins may be due, also, to these disturbances or to cooling and contraction.

After the eruptions, the crater basin was the scene of solfataric, or hot-spring and fumarole action, and the ascent of various gases and heated waters, the latter charged with silicious and metallic solutions, the copper element apparently prevailing. These charged the much-shattered and porous rocks, thoroughly impregnating them, and in places deposited solid bodies of ore in cleavage planes or other openings. The whole basin may have been once, as suggested by Professor Eames, "a boiling pool, the waters of which washed the edges of the basin as well as acted upon the deep-seated materials, dissolving out the copper from the ore and again combining with carbonic-acid gas gave rise to the coloring matter of the rocks throughout the whole basin, again depositing in their interstices the materials it had dissolved, but still leaving the main body of ore in the veins."

As the solutions forming the impregnations doubtless came from below, the Plutonic deep-seated character of the rock, the deep-seated plug, or reservoir, of the crater, as well as the fractures along the path of dikes offer strong probabilities for continuity and permanence of the ore bodies with depth, and the probability of finding valuable concentrations of ore below, of which the painted rocks on the surface are as the flower is to the fruit.

There seem great possibilities for this truly remarkable basin and its wonderful ore deposits and impregnations.

Annual Outing of the Engineering Association of the South.

On Friday, June 15, the association held its annual outing at Mt. Pleasant, Tenn. Through the kindness of President M. H. Smith, of the L. & N. R. Co., a special coach was placed at the disposal of the association. A large number of members, their friends, together with their wives and sweethearts made up the party. The run to Mt. Pleasant from Nashville was highly enjoyable, as the road traverses the most beautiful farming section of Middle Tennessee, and everywhere waving wheat and growing corn gave a glad welcome. At Mt. Pleasant the local committee on entertainment gave a hearty welcome and throughout the day exerted themselves to make every one have the most delightful time.

Mt. Pleasant, which only a few years ago was a small way station, has now suddenly sprung into importance as a great phosphate center, and its population has gone into the thousands. It has the proud distinction of shipping 100 cars per day. The industry at this point has grown marvelously, and the extensive and well equipped plants now in operation were a revelation to many of the members. The rock in this section being of exceptionally high grade much of it is exported.

At the plant of the Tennessee Phosphate Co. the party was given quite a surprise, the management having prepared delightful liquid refreshments, which served as an admirable inspiration after the fatigue of the morning. After the plants of this com-

pany were thoroughly inspected the special was run up the Mt. Pleasant Southern Railroad to the plant of the American Phosphate Co. The hour for dinner having arrived, the party left the train for a more pleasant spot. Tables had been prepared under wide spreading boughs on the banks of the Big Bigby Creek, and here a most bountiful supply of tempting eatables was spread, and needless to add this feature of the programme was slighted by no one. The ladies who have always so bountifully attended to this part of the programme seemed to have made a special effort for this occasion, and rarely is it the good fortune of one to be a participant in such a repast.

After dinner a short business session was held, and in the absence of President Geddes, Mr. John B. Atkinson, of Earlington, Ky., was called to the chair. Ballots for membership were canvassed and resulted in the election of the 15 applicants. Applications for membership were received from two gentlemen. Resignation of Mr. Howard White, Jr. was accepted. Resolutions thanking the following parties were passed: President M. H. Smith, of the L. & N. R. R., for the transportation of the party, and other officials of said road who contributed largely to the success of the occasion; the ladies; the committee on arrangements and the local committee; and the various phosphate companies. The business session then adjourned.

Under the guidance of Messrs. H. D. Ruhm, general manager, and G. F. Blackie, superintendent, of the American Phosphate Co., an inspection of their recently completed plant was made, and it was found to be a most thoroughly equipped and neatly finished one. Much credit is due Messrs. Ruhm and Blackie who were the designers and constructors. The special then made a run to the Bluegrass Phosphate Co.'s and International Phosphate Co.'s works, after inspecting which, the return trip to Nashville was begun.

The day was ideal; the company congenial; the works interesting and instructive; and in all it was one of the best outings the association has yet held.

H. M. JONES, Secretary.

Otis Feedwater Heater.

The Otis tubular feedwater heater and purifier, illustrated by the cut, is made by the Stewart Heater Co., of Buffalo, N. Y. It consists of a body or shell which is made of boiler iron or steel, on top of which is riveted a heavy cast-iron ring which has a projecting rim cast upon its outer surface, forming a flange to which the tube sheet and top dividing plate are attached by a single row of bolts. The lower end of the shell is riveted to a conical bottom, which is supported by legs as shown.

The exhaust steam enters the heater at the top, as shown in cut, passes down one section of tubes into the enlarged space of the water and oil catcher, where the water of condensation and oil are separated, and the exhaust steam then passes up through the other section of tubes, thus passing twice through the entire length of the heater, heating the feedwater to the boiling point. The exhaust steam can then be used for other purposes or exhausted into the atmosphere.

The water enters the heater near the bottom, and passing upwards in contact with the heated tubes, gradually becomes thoroughly heated, and is discharged as near the top as practicable, so as to avoid carrying the scum that is on the surface of the water into the boiler.

With this device the feedwater is thoroughly heated by the exhaust steam before it enters the boiler. Mud and sediment are separated from the feedwater and are removed quickly and easily from the heater, which also collects the scum from the surface, the water collecting and carrying off the condensation of oil from the exhaust. The company claims that these heaters will heat the feedwater to a boiling point with the exhaust steam without causing any back pressure, that all impurities are separated from the water, that the heater will not get fouled with scale, that it separates and carries off odor of condensation, that it saves oil and carries off the steam, and that a saving of 15 to 25 per cent. is effected over the use of an injector.

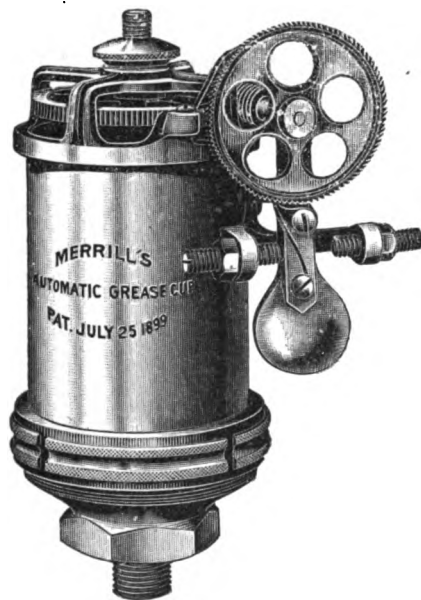


An Automatic Lubricator.

The lubricator here shown is to be attached to any reciprocating or oscillating parts of engines or machinery requiring constant and reliable lubrication, as the cross-heads, connecting-rods, eccentric straps, etc., of engines, pumps, air compressors, etc. As it feeds grease instead of oil, it may be attached in any position desired, feeding vertically upward or downward, horizontally, or at any angle desired. It feeds only when the part to which it is attached is in motion.

The base of the lubricator is screwed firmly into the part to be lubricated in the usual way. The body is attached to the base by the union nut or enlarged ring at the top. When this is unscrewed the upper part is all taken off together, the barrel is filled with a charge of grease and returned and securely clamped in the position again by the union nut. The feeding is accomplished by the pressure of the piston, and this pressure is applied by the vibrations of the pendulum seen in the front. By the adjustment of the stop-screws at the side, the pawl attached to the pendulum may be made to take from one to six or more teeth of the ratchet wheel for each vibration. On the ratchet-wheel shaft is a worm which meshes into the large worm wheel at the top. The central screw or spindle is splined, and revolves with this wheel at the same time that it travels downward by the operation of its thread in the central nut, which is screwed into the bracket or guide at the top. The feeding goes on, if the vibrations continue, until the piston reaches the bottom and the grease is all expelled. To raise the piston for refilling the barrel, the

central nut, which has a milled and notched head, is unscrewed from the bracket, the piston is pulled up, the nut is whirled down the screw by hand, and screwed tight in its place again. The ratchet wheel may be pulled around by hand until the slack is taken up and feed is fully established, and if at any time it is desirable to feed in an extra quantity of grease, this also may be done by turning the ratchet wheel. The lubricator may be made of any size and for any rate of feed desired. The one here shown will hold about 14 cubic inches, or somewhat less than half a pint of grease. The ratchet wheel has 100 teeth, the spindle has 125 teeth, the central



spindle is 24 threads to the inch, and the travel of the piston is $3\frac{1}{4}$ inches. If, then, the pendulum is set to take two teeth of the ratchet wheel for each stroke, the number of strokes required to empty the barrel will be: $(100 \div 2) \times 125 \times 24 \times 3.5 = 525,000$, and at 200 strokes per minute this would last 2,625 minutes, or say 45 hours. Any of the usual kinds of grease may be used in the lubricator, and any percentage of pure graphite may be mixed with it. The worm is of steel, and the pawls are of steel hardened, and the wheels are of hard bronze.

The lubricator was designed and patented by C. U. Merrill, of Paterson, N. J., and is made and sold by J. L. Robertson & Sons, Fulton Street, N. Y.

CURRENT MINING DECISIONS.

Prepared for MINES AND MINERALS.

A Location Notice.—A location notice of a mining claim which fails to give the direction of the initial point, or permanent monument to which it is attempted to tie the location, from the point of discovery, is void, under the statutes of Idaho.—*Brown v. Levan* (Idaho) 46 Pac. Rep. 661, affirmed. *Clearwater Short-Line Ry. Co. v. San Garde et al.*, 61 Pac. Rep. (Idaho) 157.

Lien on Mining Plant.—Illuminating oil, mica grease, lubricating oil, and gasoline for fuel used in a mining plant did not enhance the value nor become part of the machinery, and hence were not lienable, within Code Civ. Proc. § 2130, providing that every person furnishing material for any machinery, fixture, or building shall have a lien therefor.—*A. M. Holter Hardware Co. v. Ontario Mining Co. et al.*, 61 Pac. Rep. (Mont.) 8.

Natural Object or Permanent Monument.—A description in a certificate of the location of a mining claim that the mine is located in a certain section on top of the mountain south of Dew Drop Gulch is sufficient, since such gulch is a natural object or permanent monument.—*Duncan v. Fulton et al.*, 61 Pac. Rep. (Col.) 244.

Patented Mine a Natural Monument.—A description in a certificate of the location of a mining claim which locates the mine a certain distance from a patented mine is sufficient, since such patented mine will be presumed to be a natural object or permanent monument, until the contrary appears.—*Duncan v. Fulton et al.*, 61 Pac. Rep. (Col.) 244.

Partition of Surface Land.—The surface of mineral lands may be owned by one person, and the mineral underneath by another, each with an indefeasible title. When so owned, they constitute separate corporeal hereditaments, with all the incidents of separate ownership, and the surface land may be partitioned the same as where there is no mineral under it.—*Smith v. Jones et al.*, 60 Pac. Rep. (Utah) 1104.

Action to Quiet Title to Mineral Land.—In an action to quiet title to mineral land, where a conveyance from the original locators to defendant, under which he claimed, was shown to have been lost, and that he had never read it, it was not prejudicial error to allow him to testify as to when the instrument was made, and when he began work on the claim.—*Simmons v. McCarthy*, 60 Pac. Rep. (Cal.) 1057.

Safe Place to Work.—A mining company, which erects a stull or platform across a narrow and dark fissure in its mine, 70 feet from the bottom, on which its employees are required to work, is bound to the exercise of reasonable care to see that the timbers are of adequate strength and number, and securely fastened, to render it a safe place on which to work.—*Westland v. Gold Coin Mines Co.*, 101 Fed. Rep. (U. S.) 69.

Judgment for Royalties.—Where plaintiff recovers a judgment for the full value of certain coal mined by her lessee under the lease, and it is held, on appeal by the lessee, that she is entitled to recover royalties thereon, plaintiff will be given the option of either remitting so much of the judgment as is in excess of such royalties, or submitting to a new trial.—*Genet v. President, etc.*, of Delaware & Hudson Canal Co., 57 N. E. Rep. (N. Y.) 297.

Meaning of "Reprises" in Lease.—The lessee of coal lands is liable for an assessment for sewer, his covenant being to pay a stipulated rent "clear of and above all taxes and reprises," the word "reprises" meaning such deductions for burdens incident to the land as such as are required to be made from gross income in order to ascertain the clear or net profit.—*President, etc.*, of Delaware & Hudson Canal Co. v. Von Storch, 46 At. Rep. (Pa.) 575.

"Mine Run," Meaning of Term in Lease.—A mining lease stipulating for the payment to the lessor of a royalty of five cents per ton of 2,200 pounds on all lump coal mined, and five cents per ton on all "mine run" coal mined, does not entitle the lessor to a royalty on screenings, consisting of nut and slack coal left after the lump coal is separated therefrom, as the words "mine run" coal mean the coal as it comes from the mines.—*Hardin v. Thompson*, 57 S. W. Rep. (Ky.) 12.

Ambiguous Description.—A deed of mineral land described the tract conveyed as a lot situated in a certain town, county, state, "fronting 25 feet on" a certain road, "extending back east 125 feet, more or less, to the gulch, and lying about 25 or 30 feet from the south side line" of a certain claim. Held, in a suit involving its construction, that the description was not so ambiguous as to authorize the submission of the case to the jury.—*McGuigan v. Hennessy*, 61 Pac. Rep. (Mont.) 1.

Extent of Structure.—Under Hill's Ann. Laws, § 3669, providing that material men shall have liens on any "structure" where a stamp mill and tramway is built from the mill to the mine, the mill, mine, and tramway do not constitute such an entire "structure," so as to invalidate a mechanic's lien filed for material used in erecting the mill and in constructing the tramway, because such lien was not filed against the mine also.—*Watson v. Noonday Min. Co. et al.*, 60 Pac. Rep. (Ore.) 994.

Provision in Lease Regarding Culm.—Defendant leased of plaintiff all the coal contained in or under certain lands, and was to pay for coal mined and taken out, at a certain royalty per ton, on clean, merchantable coal, "exclusive of culm or mine waste which would pass through a one-half inch mesh," and that defendant should pay for 10,000 tons yearly, whether that amount was taken out or not, and interest on sums representing yearly deficiencies below 20,000 tons until that amount was reached. Held, that the provision regarding culm was to be construed as permitting defendant to mine and appropriate culm, it was liable for royalties thereon.—*Genet v. President, etc.*, of Delaware & Hudson Canal Co., 57 N. E. Rep. (N. Y.) 297.

Notes on Scientific Societies and Publications.

For Directory of Mining Societies and Mining Officials, see Advertising Page 61.

The Autumn meeting of the British Iron and Steel Institute will be held at Paris, under the auspices of the Societe d'Encouragement pour l'Industrie Nationale, on Tuesday and Wednesday, September 18 and 19, 1900.

Mr. Henry Chapman, who was honorary secretary at the meetings of the Institute at Paris in 1878 and 1889, has placed his office, 10, Rue Laffitte, at the disposal of the Institute. His manager, Mr. Henri Vaalin, who took a prominent part in organizing the previous meeting in Paris, has consented to act as honorary local secretary, and an influential reception committee is being formed.

Arrangements will be made for visiting the different sections of Metallurgy, Mining, Machinery, and Railway Plant at the Exhibition, under expert guidance; and Mr. Henri de Weddel, Bessemer Gold Medalist, has kindly intimated his intention to invite a limited number of the members to visit the works of his firm at Joeuf and Hayange, after the meeting.

Western Pennsylvania Central Mining Institute.

The summer meeting of the Western Pennsylvania Central Mining Institute was called to order in the Court House, Pittsburgh, Thursday, June 28, at 10 A. M., by President T. B. De Armit, and with a very good number of members in attendance.

After a few introductory remarks the president introduced Mr. Fred. C. Keighley, of Uniontown, Pa., who read a most interesting and exhaustive paper entitled "Bituminous Coal Mining Operations of the Past, Present, and Prospective Future."

The afternoon of Thursday was devoted to a visit to the Homestead mills of the Carnegie Steel Co., where a large number of members of the Institute were courteously shown through this interesting plant. Thursday evening a most instructing and interesting lecture on "The Geology of Pittsburgh Coal Fields" was delivered in the lecture room of the Carnegie Library by Prof. Edwin Linton, of Washington and Jefferson College. Friday morning, June 29, was given to the reading of the following papers: "Accidents in Coal Mines," by Thomas K. Adams, Mine Inspector, Mercer, Pa.; "The Progress and Prospects of Machine Mining in the Pittsburgh District," by Daniel Boden, Carnegie, Pa.; "Hints to Young Men Preparing Themselves for Mine Managers," by H. H. Stoek, Editor MINES AND MINERALS, Scranton, Pa. The session Friday afternoon was devoted to a discussion of these papers, which was very spirited and interesting.

The committee on publication reported that the proceedings of the Institute would be published in the near future. The president appointed a committee consisting of Messrs. Henry Louttit, Thos. K. Adams, and James Britt to prepare a report upon some means of preventing the use of inferior illuminating oils about the mines.

The attendance at this meeting was very much larger than at the last meeting in December, and was very good indeed for a summer meeting held during so busy a season. The increased interest in the work of the Institute reflects great credit upon its present officers, and the prospects for a large and enthusiastic meeting in December next are most encouraging. The papers read will not be extracted here, as many of them are of so much interest that they will be printed in full in coming issues of MINES AND MINERALS.

American Institute of Mining Engineers.

The seventy-ninth meeting of the Institute will be held in Canada, beginning the latter part of August, under the auspices of the Canadian Mining Institute. The sessions will be held at Sydney, Cape Breton, and Halifax, Nova Scotia; but for the convenience of members and guests from other quarters, the city of Quebec has been selected as a gathering point.

Parties arriving and reporting themselves at the Hotel Frontenac, in Quebec, a day or two before the departure of the special train for Sydney, as stated below, will enjoy, through the courtesy of the Canadian Mining Institute, special facilities for inspecting the characteristic features of that quaint and fascinating town.

A special train, composed of Pullman sleepers, dining car, baggage car, etc., will leave Quebec on the evening of August 19 and proceed direct to Sydney, Cape Breton, Nova Scotia, arriving there Monday evening. The provisional program, subject to minor changes, is as follows:

Tuesday, August 21.—Visit to steel works, now under construction, of the Dominion Iron & Steel Co., at Sydney, and the coal-handling plant at the International and other piers of the Dominion Coal Co.

Wednesday, August 22.—Excursion over the Sydney & Louisburg Railway, visiting the Caledonia, Dominion No. 1, Hub, Reserve, International, and other collieries of the Dominion Coal Co., and, time permitting, visiting the historic port of Louisburg. An alternate trip will be made to the old Sydney mines of the General Mining Association, worked as far back as 1785.

Thursday, August 23.—Sail through the beautiful Bras d'Or Lakes to Port Mulgrave, where the special train will be rejoined.

Friday, August 24.—Excursion to steel works and collieries at New Glasgow, Stellarton, Westville and other important mining districts.

Saturday, August 25, to Tuesday, August 28, will be spent at Halifax, where the members will be entertained officially and many side trips of a pleasant and interesting character will be provided by the Mining Society of Nova Scotia to the gold mines, the citadel, forts, etc.

Wednesday, August 29.—Arrival at Quebec of special train, returning from Halifax.

Arrangements can be made for a limited party to visit Newfoundland. They will take the steamer "Bruce" Thursday evening, August 23, to Port-Aux-Basques, connecting there on the following morning with the Newfoundland Railway, the transportation being furnished by Mr. R. B. Reid, proprietor of the railway, and proceeding to the Wabana iron mines of the Dominion Iron Co.; thence to St. John's, Newfoundland, where several days will be spent, and the return trip will be made by steamer "Buena Vista" (kindly placed at the disposal of the Institute by the Dominion Coal Co.) direct to North Sydney.

Applications and all correspondence on the subject of the special excursion train should be addressed to Mr. Theodore Dwight, Assistant Treasurer of the Institute, 99 John Street, New York, N. Y.

Colorado vs. Switzerland.

Switzerland, "The playground of Europe," is visited annually by over 15,000 American tourists and invalids. Why?

While the Alps have isolated peaks such as Mont Blanc (15,781 feet), and the Matterhorn (14,836 feet), the mean elevation of the highest Alpine chain is from only 8,000 to 9,000 feet. Colorado possesses more than 120 peaks over 13,500 feet in altitude, of which no fewer than 35 peaks range from 14,000 feet upward. In the whole of Europe, there are not over 12 mountain peaks of note.

The highest village in Europe is Avers Platz in Switzerland (7,500 feet); the highest inhabited point in Europe is the Hospice of St. Bernard in Switzerland (8,200 feet). In Colorado the mining town of Leadville, with 15,000 inhabitants, is 10,200 feet above sea level; other mining camps are still higher, and some gold and silver mines are worked at an altitude of over 12,000 feet.

The highest wagon road in Europe is said to be the Stelvio Road in Switzerland (9,170 feet). In Colorado the railroads cross the crest of the continent at Fremont Pass (11,328 feet), Marshall Pass (10,852 feet), and Tennessee Pass (10,433 feet). Switzerland does not possess, even in the famous St. Gothard line, any railroad engineering surpassing, if equaling, these. There are wagon roads over numerous passes in Colorado ranging from 12,000 feet upwards, the highest being Mosquito Pass (13,700 feet).

In Switzerland the cog-railroad from Vitznau to the summit of the Rigi Kulm (5,900 feet) has a length of $4\frac{1}{2}$ miles, in which the ascent is 4,072 feet. In Colorado the cog-railroad from Manitou to the summit of Pikes Peak (14,147 feet) has a length of $8\frac{1}{2}$ miles, in which the ascent is 8,100 feet, or an average of 846 feet per mile, the maximum grade being 1,320 feet.

One class of Switzerland's finest scenery is along the Via Mala, the Schyn Pass, and Urnerloch. In Colorado, the Cañon of the Arkansas with the Royal Gorge, the Black Cañon of the Gunnison, the Cañon of the Rio de las Animas, the Cañon of the Grand River, and others, are all much longer, quite as grand as and more varied in character than the best passes in Switzerland. The walls of the Cañons of the Grand River, the Gunnison, and the Arkansas rise to a sheer height of more than 2,000 feet.

It is unnecessary to speak of the mines and mills of the West located in the midst of scenery as grand as any to be found in the world.

As Colorado can be reached by at least one railroad—the Burlington—in one night from either Chicago or St. Louis, it is hard to understand why more Americans do not travel West instead of East in search of health and pleasure.

Interest Conveyed, Option.—Where a party by written contract bound himself to convey his gold interest with full warranty title, free from all incumbrances, the obligation to be of force for 12 months, if so long be necessary, only an option for 12 months was given, and if, at the expiration of that time, either party could not carry out the terms of the agreement, he was released therefrom.—*Love v. Love et al.*, 35 S. E. Rep. (S. C.) 398.

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A subscriber wishing to have his address changed, should be careful to give his former as well as his present address; otherwise we cannot find his name on our mailing list.

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MINES AND MINERALS, VOLUME XXI.

THE results of the past year have caused us to plan for the coming year along lines very similar to those which years of experience have gradually shaped into the well known policies of MINES AND MINERALS.

We cannot hope to please everybody. There are some good people whom nothing earthly can satisfy, and these we must refer to publications that have superhuman sources of information.

That MINES AND MINERALS is reaching various classes of workers is well shown by four letters recently received within the space of a single week. One says, "MINES AND MINERALS contains all coal mining. Give us some metal mining." Another says, "I wish you would occasionally print a coal-mining article. You favor metal mining too much." Still another, "Can't you make MINES AND MINERALS more scientific? It is entirely too elementary"; and still another, "Your articles are entirely too technical and hard to understand. Make them simple."

These criticisms, by their diversity, lead us to think that we are accomplishing what we set out to do; that is, to furnish mining information which will interest any mining man, whether his mine be gold, silver, coal, clay, or what not. We do not aim to publish a gold paper, a silver paper, a copper paper, or a coal paper, but we do aim to publish just what our name signifies, that is, information about mines and minerals. This, of course, includes all allied and similar branches of engineering and industry wherever these allied branches touch upon the mining field.

The all-around man wants to know what is being done by others in lines similar to his own. If he is an up-to-date business man he has inside sources of information upon his immediate business, and does not wait to find out about it from a trade paper; but he does look to his trade and technical papers to tell him what people in similar lines of business are doing, so that he may profit by their experience and adapt their ideas to his own conditions.

Under similar conditions, the results to be obtained by mining are essentially the same whatever the material mined, so that no mining man can afford to be without information upon the technical progress of the whole mining world, if he wants to be up to date and if he wishes to conduct his own particular branch of the business with the greatest economy. The great trouble with mining men has been conservatism and adherence to precedents. The coal miner too frequently thinks that the metal miner can teach him nothing, and vice versa.

Volume XXI of MINES AND MINERALS will contain descriptions of new mining districts as they are discovered and opened up, and arrangements have already been made for detailed accounts of many of the new fields which are now attracting general attention and which have not already been described in these pages.

Most interesting descriptions of a number of recently installed mining and metallurgical plants are already in hand from districts extending from British Columbia, Alaska, and Ontario, on the north, to Alabama, Mexico, and Peru, on the south. A series of articles has been arranged for contrasting the mining practice of the old world, as it is exhibited at the Paris Exposition, with our own present practice. These articles will be prepared by the superintendent of one of the most progressive and up-to-date mining-machinery companies in the United States.

Through the cooperation of our subscribers the interest in the Correspondence Department of MINES AND MINERALS has greatly increased during the past year. The success of this department depends entirely upon the use made of it by subscribers. Its effectiveness has recently been increased, we believe, by answering directly from this office many of the questions received. Certain questions are left open for general controversy, as heretofore.

The descriptions of new machinery which appear from month to month are not, as many seem to suppose, advertisements for

which pay is received. Descriptions of new devices and appliances which are of interest to all mining men are always welcome, and whenever possible they receive a prompt and prominent place in our columns, and it should be understood that all such notices receive the same careful editing as any other reading article. Every effort is made to verify the claims of the builders or makers of such machinery or device.

The department of Examination Questions for Mine Managers, Mine Foremen, Fire Bosses, etc., is, we believe, being constantly improved, and every effort is being made to make these columns as helpful as possible to all those who are preparing themselves for such examinations. These State Examinations are becoming more and more rigid every year, while additional States are constantly adding such requirements.

Suggestions in regard to the conduct of any of these departments are at all times most welcome. If you have criticisms to make, send them to the editor, so that he may profit by them. Do not growl behind his back and then wonder why he does not do so and so, as you think it should be done. We are always glad to adopt practical suggestions if possible, or, if they cannot be adopted, to give a reason for not doing so. Write to us occasionally, suggesting subjects that would interest the people in your neighborhood, and we can usually arrange to furnish the desired information.

Finally, don't fail to carefully consult the advertising pages of MINES AND MINERALS whenever you wish to go into the market for mining machinery and appliances. A constant perusal of the advertising pages of any up-to-date journal is one of the best ways to keep in touch with the latest developments, and when writing to any advertiser mention where you saw his advertisement. It encourages him to advertise more freely, is a benefit to us, and gives you a better paper; for it is universally recognized that the amount and character of matter in the reading pages is a direct reflection of the amount and character of the advertising pages.

STRENGTH OF COAL.

AN editorial in the May issue of MINES AND MINERALS described some preliminary tests made by Mr. Wm. Griffith to determine the compressive strength of anthracite coal. The committee appointed by the Scranton Engineers' Club, to further investigate the subject, has perfected its plans for carrying out the tests as soon as the proper samples are secured. The following circular has been sent out asking for the cooperation of the coal operators of the Wyoming and Lackawanna valleys.

The committee of tests will be very glad to receive any suggestions in regard to the work, and would particularly like to receive the results of any similar tests that have been made.

SCRANTON ENGINEERS' CLUB.

SCRANTON, PA., July 18, 1900.

DEAR SIR:—At a recent meeting of the Scranton Engineers' Club, Mr. William Griffith, of Scranton, reported the result of a few tests which he had made to determine the compressive strength of anthracite coal.

These preliminary experiments indicate that different seams in the same colliery have very different compressive strengths, and if this be the case, the present practice of laying out the pillars without respect to the compressive strength of the coal might be changed with great advantage to the operator in saving disastrous and expensive results. Such information would also afford a means of determining where larger pillars were necessary, where smaller ones could be used with safety, and whether any part of a mine is likely to cave or squeeze, etc.

These preliminary tests and Mr. Griffith's suggestions so impressed the Scranton Engineers' Club, that a committee has been appointed to investigate this subject. The Dickson Mfg. Co. has courteously extended to this committee the privilege of using its testing machines, and the authorities in charge of the testing laboratories at Cornell University and the Pennsylvania State College have offered to test, free of charge, any specimens that may be sent to them.

The value of the results obtained by these tests will depend very largely upon the number of samples which it is possible to procure, and the extent of the territory from which these samples are obtained.

Will not your company assist in this work by having a number of specimens prepared in accordance with the following specifications and sending one set prepared and properly labeled to each of the following addresses: One set to Mr. William Griffith, Coal Exchange, Scranton, Pa.; one set to Prof. R. C. Carpenter, Professor of Experimental Engineering, Cornell University, Ithaca, N. Y.; one set to Prof. Louis E. Reber, Pennsylvania State College, State College, Pa.

These specimens should be prepared as follows: (1) One specimen should be exactly cubed, and should be 2 inches on the side. (2) A piece of the same coal, 2 in. × 2 in. square and 4 inches high. (3) A piece of the same coal, 2 in. × 2 in. square and 1 inch high. If only one sample can be furnished the cube is preferred. The base of the sample should be parallel to the bedding plane of the coal.

Each set of the specimens should be of the same quality, and, if possible, sawed out of one large lump.

Each specimen should be carefully labeled and described on one of the enclosed blanks and wrapped with the label inside of the wrapper. If you can send only one set kindly forward that to Mr. Griffith, prepaid.

A report of these tests will be furnished to all who assist in any way in carrying out the tests.

Kindly fill out the enclosed postal card signifying whether you will assist us in this work and return the same at once stating what specimens you can furnish, from what locality and coal seams these specimens will be taken, and how many sets of samples you can send.

Committee { Wm. Griffith, Chairman,
J. H. FISHER,
MORGAN DAVIS,
HARRY E. YEWENS,
H. H. STOEK.

A copy of this circular letter has been sent to the superintendent of every mine in the Lackawanna and Wyoming valleys as given in the last report of the Bureau of Mines.

DESCRIPTION OF THE SPECIMEN.

1. Location of colliery; 2. Operator; 3. Size of specimen; 4. Seam from which taken; 5. Location from which taken, i. e. near basin, outcrop, or saddle; 6. Pitch of the seam; 7. Character of the coal—glassy, checker, bright, or dull; 8. Depth below surface; 9. Face coal or pillar coal; 10. If pillar coal, how long has pillar been standing?

UNITED STATES GEOLOGICAL SURVEY.

THE last session of Congress recognized, in a fitting and substantial way, the increasing importance and value of the work of the United States Geological Survey.

This survey is at present the chief representative of the mining interests in the Federal Government, hence any contemplated action upon the part of Congress which will increase its efficiency should receive the hearty support of the mining fraternity.

For many years there were two prime causes of complaint against the Survey in mining circles:

1. The great delay in printing the reports of work done.
2. The small amount of economic work which was carried on, and the very small amount of attention given to practical mining.

The former defect has been largely remedied, during late years, by the prompt appearances of preliminary reports, which are now published as soon as the information is collected, without waiting for the complete volume of statistics, official reports, etc.

The answer to the second question has always been that the appropriations made by Congress did not permit of any enlargement of the work of the Survey, which was, of course, primarily for scientific and geological work. The increased appropriations of the last Congress are a step towards the removal of this reason, and mining men throughout the country will await with interest some results that will appeal to them more directly than do the purely scientific reports. This is not intended in any way as a reflection upon the character of these reports, whose value is too well known, but is simply a statement of facts as they appear to the miner.

A letter recently received from Mr. Walcott, Director of the United States Geological Survey, shows that with the increased appropriation more extended economic work is to be undertaken, while the enlargement of the chemical and physical laboratories should permit of work being carried on of direct and important interest to the practical side of mining. Mr. Walcott says:

"Congress increased the appropriation for Geology \$60,000, and Mineral Resources \$20,000. With this increase we have been able to reorganize the geologic work so as to provide for a considerable extension of the economic work of the Survey.

"The division of Mineral Resources will continue the collection of mineral statistics, including those of gold and silver as mineral products, and in addition, this division will be charged with the important function of keeping the Survey in touch with mining schools and bureaus, and economic work of the various State Geological Surveys.

"The division of Chemical and Physical Researches is to be enlarged by the installation of needed chemical and physical apparatus, and the doubling of

the force employed, and of the space allotted to the laboratories. This division will cooperate with the division of Mineral Resources and the section of Economic Geology.

"The section of Economic Geology is organized with Mr. S. F. Emmons in charge of the investigations of metallic ores, with the exception of iron, which is in charge of Prof. C. R. Van Hise. Dr. C. Willard Hayes will have charge of the investigations pertaining to the non-metallic economic products. The section of Economic Geology will cooperate with the sections of Areal, Pleistocene, and Pre-Cambrian and Metamorphic Geology, and division of Mineral Resources.

"The sections of Areal and Pleistocene Geology will have charge of the areal mapping and stratigraphic work connected with the distribution of all sedimentary rocks. This includes the mapping of all mineral deposits which have occurred in any considerable areal distribution.

"The division of Hydrography was greatly strengthened by an increase of \$50,000 in its appropriation. Under this, economic questions pertaining to the distribution and utilization of the water resources of the country, including irrigation and power, will be carried forward to a greater extent than has been possible heretofore.

"As a whole the Survey stands in a better position to aid the mineral producers of the country than ever before. If as much progress is made at the next session of Congress, matters will be in a very satisfactory condition."

The work of the Survey in the past speaks for itself, and it is hoped that Congress will continue the liberal policy begun at the last session, so that the plans now being inaugurated may be successfully carried out.

Book Review.

JOURNAL OF THE MINING SOCIETY OF NOVA SCOTIA, Volume V.

BULLETIN OF DEPARTMENT OF LABOR, No. 28, Washington, D. C.

MINE DEVELOPMENT THE BASIS OF PROSPERITY, by Almarin B. Paul, M. E., San Francisco, Cal.

GEOLOGICAL SURVEY OF MISSOURI. Volume XII, Part I. Report on Green County, by Edward M. Shepard.

GOLD MEASURES OF NOVA SCOTIA AND DEEP MINING, by E. R. Faribault, B. Sc. Published by the Mining Society of Nova Scotia, Halifax, N. S.

OBJECTS AND POSSIBILITIES OF CREDIT MEN'S ASSOCIATIONS. An address given before the Rochester Credit Men's Association, at Rochester, N. Y., April 17, 1900, by Daniel B. Murphy.

PROPOSED STANDARD SPECIFICATIONS for steel bridges, ships, buildings, boiler plate, rivets, steel rails, spliced bars, axles, tires, forgings, castings, and specifications for wrought iron; also the report of the American Branch of the Committee of the International Association for Testing Materials. J. M. Porter, Secretary of Publication Committee, Easton, Pa.

GEOLOGICAL SURVEY OF ALABAMA. Report of the Warrior Coal Basin, by Henry McCalley, Assistant State Geologist, University, Ala. 327 pages, illustrated. This report contains an introductory chapter of 8 pages, which gives a general description of the Warrior Coal Field, and is followed by separate chapters upon the Black Creek, Horse Creek, Pratt, Gwin, and Brookwood groups of coals. An appendix contains records of drillings and shafts.

SUPPORT YOURSELF WHILE LEARNING A PROFESSION. An interesting story of young men who have fitted themselves for good positions in architectural, mechanical, and electrical engineering work is told in this little book. Its motto is "to earn more, learn more" and the value of a technical education and the ease with which it may be acquired are illustrated with many examples of young men who have spent their spare time in study and risen from the ranks to important positions in professional life. The book will be sent free on application to The International Correspondence Schools, Scranton, Pa.

ENCYCLOPEDIA OF MEXICAN MINING LAWS, by Richard E. Chism, Ph. D., City of Mexico, Mexico. Price \$2. 201 pages. This handy volume should be of great value to all who are interested in Mexican mining matters, as it contains, alphabetically arranged, a large amount of information in regard to Mexican laws. This information is rendered easily available by a comprehensive index of 32 pages, which adds greatly to the value of the book. It also contains as an appendix, a glossary of Mexican mining terms. Mr. Chism has certainly presented, in a very neat form, information that will be particularly acceptable at the present time when there is so much interest being taken in mining matters in the Spanish-American countries.

MECHANICAL EQUIPMENT OF THE NEW SOUTH STATION, BOSTON, MASS., by Walter C. Kerr. A paper read before the American Society of Mechanical Engineers, December 18, 1899. This paper describes the equipment of the station in detail under the following heads: Powerhouse; Interlocking Switch and Signal System; The Electric Plant; Heating and Ventilating; Disposal of

Drainage from Waterproofed Structure; Roof Drainage; Ice-Making, Refrigerating, and Water-Cooling Plants; Car Heating in Train Shed and Yards; Air-Brake Charging; Steam and Hot-Water Supply to Head House; Fire Protection; Elevators, Baggage and Express Lifts. It will be of unusual interest to any one identified with these branches of engineering, as the descriptions given here are detailed and the illustrations very profuse. Copies of this paper can be secured from the Publishing Department of the Westinghouse Co., Pittsburgh, Pa.

THE CYANIDE PROCESS, by J. Parke. A practical book published by C. Griffin & Co., Limited, London, and J. B. Lippincott & Co., Philadelphia, Pa. Bound in cloth. Price, \$2. This is the first English edition of the valuable work on the cyanide process, which has gone through three editions in New Zealand. The text is fully illustrated by cuts, many of which are in the form of large folders. Some very valuable information has been added upon the cyanide treatment of slimes and antitoxes for potassium cyanide poisoning, also an appendix treating of the special method of cyaniding now in use in New Zealand, in which the ores are practically all crushed wet. This book has already made its name as an extremely handy manual for any one interested in this process, and in its present revised form it should be welcomed not only by those already familiar with it, but by all who are interested in the recovery of the precious metals by this process.

HORSELESS VEHICLES, AUTOMOBILES, MOTOR CYCLES, OPERATED BY STEAM, HYDROCARBON, ELECTRIC, AND PNEUMATIC MOTORS, by Gardner D. Hiscock. M. E. Norman W. Henley & Co., 132 Nassau Street, New York. Price, \$3. Those who have read the earlier works of the author of this book will not be disappointed with this, his latest effort. It is made up very largely of catalogue descriptions and illustrations of nearly every type of motor vehicle that has been introduced in America up to the present time. The general reader who is interested in knowing what has been done in this field and who cares more for an outline of the leading features of the different types than for accurate technical information will find much that is interesting and some that is instructive in the pages of this book. The engineer, however, who has given the development of horseless locomotion some study will find nothing in it that will be new, while the student who wants principles or the designer who is searching for practical information that will assist in the proportioning of vehicles or the motors and gearing by which they are propelled will find that these points are as carefully concealed as they are in the catalogues of the most conservative builders.

THE INDIANA DEPARTMENT OF GEOLOGY AND NATURAL RESOURCES, TWENTY-FOURTH ANNUAL REPORT, 1899, W. S. Blatchley, Indianapolis, Ind. 1,078 pages, illustrated. This report contains a chapter upon the natural resources of Indiana by the State Geologist; the reports of the State Inspector of Mines, of the State Natural Gas Supervisor, and of the State Supervisor of Oil Inspection. Also the following reports upon natural history subjects: General Discussion of the Middle Silurian Rocks of the Cincinnati Anticlinal Region, with their Synonyms, by August F. Foerste; Report upon the Waldron Shale and Its Horizon, by J. A. Price; Dragonflies of Indiana, by E. B. Williamson; Batrachians and Reptiles of Vigo County, by W. S. Blatchley; Catalogue of the Flowering Plants and of the Ferns and Their Allies Indigenous to Indiana, by Stanley Coulter. The report of the State Inspector of Mines shows the coal trade in the State to have been of a very satisfactory condition during the year 1899, with good prices, a firm market, and a demand in excess of the supply, and with comparatively few labor troubles. Nine new mines were opened up during the year and a new coal field is reported as having been entered by the Indiana Southern Railroad. This report also contains the Terre Haute agreement between proprietors and miners extending from April 1, 1899, to April 1, 1900; also the usual statistical tables of production, accidents, etc. The Inspector, Mr. Epperson, emphasizes the necessity for more complete and accurate mining maps. He also makes suggestions as to need of legislation in Indiana, and closes his report with a description of a number of the mines in the State and with an account of the Indiana Mining Institute for the year.

METALLURGY OF SILVER. By H. F. Collins, being Part II of the Metallurgy of Lead and Silver of Griffin's Metallurgical Series. Edited by Prof. Roberts-Austen. Published by Charles Griffin & Co., Limited, London, and J. B. Lippincott & Co., Philadelphia, Pa. Bound in cloth. Price, \$4.50. The general style and arrangement of this work are similar to those of the metallurgy of lead. Tables of comparison form a very important feature of the work, as do the comparison of advantages and disadvantages of the various processes, which are arranged in columns on the same page so that the advantages and disadvantages come parallel with one another. The author states in the preface that obsolete processes have been only casually mentioned,

the idea being that any one who is interested in historical metallurgy would do better to consult pages of authors who were more nearly contemporary with the processes they describe, the aim of the work being to furnish a practical book for working metallurgists. The work covers a discussion of silver and its ores, amalgamation processes, including the patio, Cazo, Fondon, Krohnke, and Tina processes, the pan process, the roasting and amalgamation processes with pans or barrels; the treatment of tailings and the concentration of silver ores, and the retorting, melting, and assaying of silver bullion, and the chloridizing-roasting; the lixiviation processes are then taken up, including the Augustin, Claudet, and Ziervogel processes, the hyposulphite and leaching processes and practice, and the refining of lixiviation sulphides. The next section treats of smelting processes, including matte smelting in the blast furnace, pyritic smelting, matte smelting in reverberatories, the treatment of argentiferous mattes, and silver-copper smelting.

THE METALLURGY OF LEAD, by H. F. Collins, being Part I of the Metallurgy of Lead and Silver which belong to the Griffin metallurgical series. Edited by Prof. Roberts-Austen. Published by C. Griffin & Co., Limited, London, Eng., and by J. B. Lippincott & Co., Philadelphia, Pa. Bound in cloth. Price \$1.50. This book fills a gap in the series of metallurgical literature by describing the processes used in Australia, and treating the English work from an English standpoint. For the American work on this subject the author acknowledges his indebtedness, in a large degree, to Hoffman's Metallurgy of Lead, and for the German practice, to Schnabel's work on the same subject. The work is very clearly arranged, and contains many illustrations. One interesting feature of the work is the careful, systematic arrangement of information in tables. These tables cover most of the features of the subject, comparing the ore treatment, products obtained, including slags, mattes, etc., comparison of methods used in different districts, costs, and many other interesting factors. These tables bring the matter before one in a manner totally impossible to accomplish in the ordinary text style. The scope covered by the work includes the sampling and assaying of lead and silver ores, which has been reduced to as narrow limits as possible, the assumption being, evidently, that this matter belongs more to the assayer than to the metallurgist, and the space in the book being reserved largely for the metallurgical treatment. The properties of lead, its principal compounds, and lead ores, are thoroughly treated, after which lead smelting is taken up in its various branches, including smelting in the reverberatories, in hearths, the roasting of lead ores, blast-furnace lead smelting, including both the principles and the plant required, blast-furnace products, samples of blast-furnace work, flue dust, its composition, collection, and treatment, cost, losses, and the purchase of ores; treatment of zinc-lead sulphides, desilverization, including the shipping and refining for market, the Pattinson process, the Parke's process, and the cupeling and refining of the products.

GAS-ENGINE CONSTRUCTION. A Practical Treatise Describing the Theory and Principles of the Action of Gas Engines of various Types, and the Design and Construction of a Half-Horsepower Gas Engine, by Henry V. A. Parsell, Jr., and Arthur J. Weed, M. E. Norman W. Henley & Co., 132 Nassau Street, New York. Price, \$2.50. This is preeminently a book for the amateur and contains only so much of theory as is required to enable the beginner to understand the general principles on which the action of the gas engine depends and the purpose of the various parts that enter into the construction of the more common types of this motor. The descriptive matter is also limited to the illustration of a representative engine of each of the different classes, with a brief explanation of its leading features. The greater part of the space is taken up with directions for the construction of a 2½ in. × 4 in. horizontal four-cycle gas or gasoline engine, rated at ½ horsepower. Complete working drawings of all the details, together with very thorough instructions for performing the different operations involved in their construction are given. The instructions cover all the different steps of patternmaking and machinery, and are made particularly clear by means of halftone reproductions of photographs of the patterns, the methods of fastening the work in the lathe for the different operations, and of the various steps involved in finishing the parts and assembling them. The work is so designed that the only machine actually required in finishing all parts of the engine except the flywheels is a lathe with an 8-inch swing. With this and the requisite small tools any careful amateur can, by following the instructions given, feel confident that his labors will be rewarded by the production of a successful motor.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

RUE MFG. CO., Philadelphia, Pa. "Injectors." 8-page pamphlet.

GENERAL COMPRESSED-AIR HOUSE-CLEANING CO., St. Louis, Mo. "Compressed-Air House-Cleaning."

DETROIT LUBRICATOR CO., Detroit, Mich. 56 pages, showing many different types of lubricators manufactured by them.

FAIRBANKS, MORSE & CO., Chicago, Ill. "Hoists and Air Compressors." Handsomely illustrated and well gotten up.

HIBBARD-RODMAN-ELY SAFE CO., New York City, N. Y. 4-page circular, describing "The New Manganese Steel Bank Safe."

CHAS. L. HEISLER, Erie, Pa. Circulars describing the Heisler Steam Road Roller and the Heisler High-Duty Pumping Engine.

H. K. PORTER CO., Pittsburg, Pa. "Light Locomotives," 236 pages, very nicely illustrated, and giving price lists, etc., of these locomotives.

DEAN BROS. STEAM PUMP WORKS, Indianapolis, Ind. "Duplex Steam Pumps." Catalogue No. 38. 40 pages, nicely gotten up and well illustrated.

MEITZ & WEISS, New York, N. Y. "Gas and Kerosene Engine." 24 pages, showing different views of this engine and a number of places where they are in use.

NORTH AMERICAN METALINE CO., New York City, N. Y. 24-page circular, containing testimonials from many of the large mining companies, etc., who have used metaline.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. "Record of Recent Construction" No. 19, May, 1900. 32 pages, with views of the many different styles of locomotives built by this company.

JACKSON DRILL & MFG. CO., Denver, Col. "The Jackson Hand-Power Rock Drill." 16 pages, showing the use of these drills in mines and giving a number of testimonials from mining companies using them.

HOOVER PNEUMATIC MILLING CO., P. O. Box 200, Baltimore, Md. Small pamphlet describing a modern dry method of milling ores, the Kent mining mill pulverizer, and the Sturtevant centrifugal rolls for dry pulverizing.

JEFFREY MFG. CO., Columbus, Ohio. "Jeffrey Coal-Mining Machinery." 76 pages, handsomely illustrated, showing a great many different types of machines and also a number of places where these machines are in use.

FRASER & CHALMERS, Chicago, Ill. "Hoisting Engines and Appliances." 120 pages, describing their single-drum hoisting engines, double-drum hoisting engines, conical-drum hoisting engines, reel hoisting engines, and horsepower hoist.

WEBER GAS AND GASOLINE ENGINE CO., Kansas City, Mo. "Gas and Gasoline Engines and Hoists." 72 pages, describing the economy, efficiency, material, workmanship, design, and strength of the engines and hoists made by this well known firm.

BULLOCK ELECTRIC MFG. CO., Cincinnati, Ohio. Souvenir of the Master Mechanics' and Master Car Builders' Convention, Saratoga, N. Y., June 18 to 23, 1900. Handsomely illustrated, containing views of the different departments of the offices of this firm, and also a number of the machines manufactured by them.

GENERAL ELECTRIC CO., Schenectady, N. Y. Price List No. 7,523, "Sockets and Receptacles"; Bulletin No. 4,223, "The Thomson Recording Wattmeter for Street-Railway Service"; No. 4,224, "Air Blast Transformers"; No. 4,225, "Direct-Driven Continuous-Current Generators for Lighting and Power." Flyer No. 2,055, "Pendant Push-Button Switches."

In their semimonthly review of the lead and zinc mining district, dated June 30, 1900, the Lyon & Leddy Co., Joplin, Mo., says: The close of the first six months of the present year finds zinc ore selling at from \$25 to \$26 per ton, as against \$44 per ton one year ago, while lead is now quoted at \$24 per thousand pounds on a strong market, as against \$26 for the corresponding period last year. During the past week lead advanced \$5 per ton over the preceding week, while zinc is lower by from \$1 to \$2 per ton.

The total production for the six months ending June 30 amounted to 129,462 tons of zinc and 14,105 tons of lead, at a value of \$4,367,082. This is 3,964 tons less zinc, 2,177 tons more lead, and \$1,412,095 less in value than the production of the first six months of 1899. Compared with the same period of 1898 it is an increase of 20,173 tons of zinc, a decrease of 459 tons of lead, and an increase of \$1,235,277 in value.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Effect of Gasoline Engine on Ventilation.

Editor Mines and Minerals:

SIR:—What would be the effect of a gasoline engine upon the ventilation of a mine? Yours truly,
Birmingham, Ala. JAS. DAVIS.

Messrs. Fairbanks, Morse & Co., of Chicago, have replied to the above inquiry as follows: Without knowing the exact location and conditions, it is rather difficult for us to advise you fully upon the subject of using a gasoline engine in a mine, but would say that we have one or two engines direct connected to pumps which are installed in mines for the purpose of pumping water. The engines in question are back in tunnels such a distance that an exhaust pipe would have been very expensive, and the engine has been installed so that the exhaust was carried to the top of the tunnel and allowed to escape. The heated air, which is about all that there is of the exhaust from our engines, works its way along the top of the tunnel to the vertical shaft. The engine drawing in fresh air from the floor of the tunnel and exhausting hot air at the top, would have a tendency to set up an artificial circulation of air in the mine. If there was no ventilation in the tunnel, we rather think it would be best to use an exhaust, even though it were a considerable length, as this would do away with any possible fouling of the tunnel. Sometimes it can be arranged to bore a small hole down to the tunnel, and this hole, by extending the pipe a few feet into the same, can then be used as the exhaust conduit, and the draft caused by the exhaust will also assist in ventilating. So far we have never found a case where we could not arrange to install gasoline engines for pumping.

Horsepower of a Boiler.

Editor Mines and Minerals:

SIR:—Which is the correct method of ascertaining the horsepower of steam boilers? Here is an example: One cylinder boiler 36 feet long, 36 inches in diameter; 80 pounds steam pressure. What is the horsepower of the above boiler? Yours truly,
Taylor, Pa. W. B. OWEN.

The horsepower of a boiler is calculated most accurately when we know the weight of water evaporated per hour and the temperature of the feedwater, by dividing the weight of water evaporated (lb. per hr.) by 34.5, and multiplying the quotient by a factor taken from a table giving the factor of evaporation. Such tables are published in many steam engineer's handbooks. For example, if the boiler requires 45 gallons of water per hour, and the temperature of this feedwater is 40° F., since the factor of evaporation for 80 pounds gauge pressure and feedwater at a temperature of 40° F. is 1.214, we have in this case, using the above formula,

$$H = \frac{45 \times 8\frac{1}{2} \times 1.214}{34.5} = 13.195 \text{ H. P.}$$

It is usual practice, however, for boilermakers to calculate the horsepower of a boiler from its heating surface, for different types of boilers; dividing the heating surface by a factor, which experience has shown to be approximately correct for a given type of boiler. The factors in common use for this purpose are given in the following tables:

Type of Boiler.	Heating Surface per H. P. (sq. ft.).
Cylinder	6 to 10
Flue	8 to 12
Tubular	14 to 18
Vertical	15 to 20
Water tube	10 to 12
Locomotive	1 to 2

In the present case, assuming that $\frac{1}{2}$ of the perimeter is heated throughout the entire length of the boiler, we have,
 $3.1416 \times 36 \times 36 = 113$ square feet heating surface. For this
 3×12
 type of boiler, according to the style and size of the firebox, there is considerable variation in the number of square feet of heating

surface per horsepower (6 to 10 sq. ft.). Assuming 9 square feet of heating surface per horsepower, we have $\frac{113}{9} = 12.55$ H. P.

The Relation of Magnetic Iron to Copper Ores.

Editor Mines and Minerals:

SIR:—As magnetic iron frequently forms the capping of copper lodes, is it a generally accepted theory that magnetic iron has its origin in the decomposition or oxidation of such copper minerals as chalcopyrite? Yours truly,

Port Renfrew, Vancouver Island, B. C. LEWIS KIRKPATRICK.

We think not.

Size of Shaft.

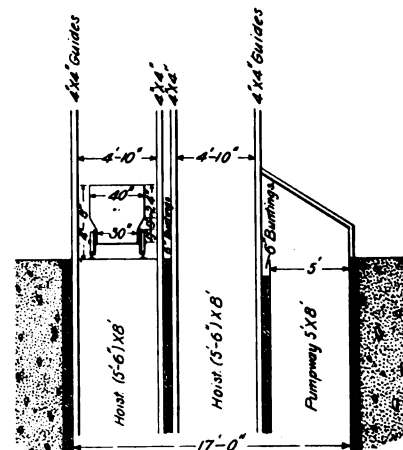
Editor Mines and Minerals:

SIR:—I am not in the habit of bothering any person, but I would be very thankful if you would please give me the size of a shaft, inside of timbers, to suit the following conditions: Shaft to have three compartments, two hoistingways, one airway; capacity of mine cars, 2 tons; depth of shaft, 250 feet; coal seam nearly flat, 8 feet thick, and generating much gas, and to hoist 1,000 tons per 10 hours. The mine will have 400 men and 20 mules.

Yours truly,
J. H. S.

Haffey P. O., Pa.

One thousand tons in 10 hours = 100 tons per hour; and since the capacity of the mine car is 2 tons, $\frac{100}{2} = 50$, is the required number of trips per hour. With a good equipment at the upper and lower landing of this shaft, we can reduce the time of hoisting, or increase the number of trips per hour to a considerable extent, which would reduce the size of the mine car required. We offer this simply as a suggestion, since a mine car of 2 tons capacity is not always easily handled at the face. The height of the seam being 8 feet, we would adopt a mine car having the dimensions marked in the accompanying sketch, and having 14-inch or 16-inch wheels. With these dimensions, the car may be made 6 feet long, inside measurement, and may be loaded 10 inches over the top of the car, which would require a height above the top of the ties of 5 feet 4 inches in the clear, or say 6 feet. This can readily be obtained in an 8-foot seam. The inside length of the car being 6 feet, the width of the shaft should not be less than 8 feet in the clear. As shown in the sketch, the clearance between the guides should not be less than 4 feet 10 inches, and using 4-inch guides, the size of each hoistway will be (5 ft. 6 in.) $\times$ 8 ft. The size of the pumpway should not be less than 5 ft. $\times$ 8 ft. in order to give ample room for a ladderway, if desired, and for the necessary pipe lines. Using 6-inch bunting between these several compartments, we have for the size of the shaft in the clear 8 ft. $\times$ 17 ft. It is always good practice to have the hoisting shaft of a size sufficient to meet every emergency that may arise, although on account of the expense of excavation and the timbering, the size of the shaft should not be larger than what is required.



Haulage Problem.

Editor Mines and Minerals:

SIR:—If the modulus of elasticity is 29,000,000; the elastic limit 57,000 pounds; the working load is one-fifth of the ultimate strength of the rope, which is 1 inch in diameter composed of six strands of seven wires each, or a total of 42 wires, of material that has a breaking strain of 201,600 pounds per square inch, (1) what is the minimum diameter of drum on which this rope may be used? (2) What is the bending strain? (3) What is the radius of a curve, on which 8-inch sheaves are set 3 feet apart, that will give the same bend in the rope at each 8-inch sheave, as if the rope were going round a sheave of minimum diameter for this rope? (4) What in case (3) will be the bending stress? The writer is familiar with lots of literature on these points, but there is such a wide variation in the results that he consulted lots of his friends on the subject to find that they are as much at sea as himself, or if the results are satisfactory to them they will agree with nothing else.

The writer is familiar with makers' statements as to size of drums in their catalogues; but how do they arrive at the sizes? Will some able correspondent thrash these points out for the benefit of your many readers?

Lethbridge, Alta., Can.

Yours truly,
H. L. D. W.

Value of Coal Lands.

Editor Mines and Minerals:

SIR:—I have very pressing need of some reliable estimate of the value of unimproved coal lands in Pennsylvania. Can you tell me what such lands are generally in your State considered to be worth? I mean lands holding at least one seam of bituminous coal 3 feet or more in thickness, and of quality that would make it always salable? I know that proximity to railroad lines would be an important item, so please say what such lands would bring when near railroad, for that would be about the kind that I am asking about. Also, are lands leased on royalty in your State, and if so, at about what rate per ton? Are sales based upon royalty estimates, i. e., upon the calculation of so many tons of coal to the acre? I hope I shall not be taxing your time too much in asking you to give me this information.

Yours truly,
S. A.

Bituminous coal lands such as you describe sell in Pennsylvania at the present time for from \$25 to \$50 per acre. Several tracts of this character, having good railway connections, have sold at \$27, \$35, and \$40 per acre, respectively. A large tract of bituminous coal land in the western part of Pennsylvania which was sold for \$7 per acre in 1892 is, we are told, now held at \$50 per acre. Similar lands are held in West Virginia at about the same figure or possibly slightly less. These figures apply to non-coking coals, and the values for coking coals are considerably higher. As you know there has been great activity in the coking coal lands of Western Pennsylvania during the last year, and a great many deals have been reported in which the price paid was given as \$1,000 per acre. These prices are probably accurate for coal lands bordering on the celebrated Connellsville coal region. Sales of coal lands in this State are not based on royalty estimates but are straight out-and-out sales. There are a great many royalty leases in this State, and the royalties on bituminous coal, non-coking, vary from 5 to 12½ cents per ton. Coking coal royalties are higher, and we know of one such royalty of 17½ cents per ton, and another of 15 cents per ton for the first five years with an increase of 1 cent per ton for every five years. Anthracite royalties are very much higher, varying from 25 to 50 cents per ton, depending largely upon the date at which the leases were made. The present average royalty would probably be about 40 cents per ton, though in exceptional cases, 55 and 75 cents have been obtained.

Coeur d'Alene District, Idaho.

Editor Mines and Minerals:

SIR:—The commencement, this week, of shipments from the Terrible-Edith, a mile above Murray, marks an era in Coeur d'Alene mining. Situated within six miles of the first discovery of gold in the Coeur d'Alenes, these claims lay untouched for almost 17 years, although they were located within a year after the first rush into Eagle, in 1883, and it was known at that time that there was an abundance of carbonate of lead and some galena on the surface where the discovery was made. Since their location the annual assessment work has been done in a tunnel which was being run on the end line common to the two claims, and this spring, when in 250 feet, the vein was cut, showing 4 feet of lead ore, nearly all of which would bear shipment, although it necessitated a haul by wagons of 17 miles over two ranges of mountains. The drifting since has been to the west, and the vein has widened to 7 feet between walls, although the ore is not so good as where first cut, and only a small part of it will bear shipment without concentration. Six or eight miles east from there, nearer the head of Prichard Creek, there is a lead-bearing belt on which are three or four claims which have shipped ore, it being hauled by wagons to Thompson Falls, Mont., the claims being so near the summit of the Bitter Root range that there was but little mountain to climb with the ore, but this from the Terrible-Edith is the first from near Murray.

The further development of the property will be closely watched by local students of mining methods and conditions, as it appears to be different from any of the developed claims in that district. It was at first considered a strictly gold-bearing region, the presence of lead ore being known to but few and overlooked by them. The ledges are usually of the blanket class, only dipping from 10° to 20° from the horizontal, and carry no mineral in quantities except gold and iron, there being enough silver with the gold to make the common value from \$15.50 to \$16.50 per ounce. Occasional traces of copper are found, but never more than traces, while lead and zinc were unknown. So far as the writer is informed, aside from the Terrible-Edith, no

lead-bearing vein there has been developed to any considerable extent, although a number of others are known to exist, including one of sand carbonate from which lead can be extracted in an ordinary blacksmith's forge. One mammoth vein on the Daddy carries some lead, together with gold, silver, and a little copper, but it has never been worked. A noticeable difference between the lead- and gold-bearing veins is that the former are nearly perpendicular, although there is at least one gold-bearing vein of the same nature. They are also larger than those in which gold forms the principal value, the latter usually being from 6 inches to 2 feet, and narrowing down to a knife blade as often as they widen to over 4 feet. Whether or not there are other differences cannot be told until there is more development work in the lead ores.

A number of other lead discoveries have been made in the neighborhood this spring, and the renewed hope of getting a railroad to Murray will stimulate work on them this year, as the development of any considerable bodies of lead ore would be a powerful stimulus to railroad men to build, and there is likely to be considerable light thrown on the secrets of the Coeur d'Alene "gold belt" before the century ends.

Yours truly,
Wallace, Idaho.
W. C. CLARK.

Centrifugal Ventilators.

Editor Mines and Minerals:

SIR:—The version which Mr. Beard puts on the mathematical proof of approximate identity which I have shown for pav and

$Q_0 p_0 \log \text{nat } \frac{p_1}{p_0}$ is not correct. The demonstration merely shows that Qp is an approximate value of the work of compression which makes it identical with the work done by the total pressure pa on the cross-section of the airway, exerted through the distance v , and no more.

It is true that the compressive formula may be written as $Q_1 p_1 \log \text{nat } \frac{p_1}{p_0}$ in place of $Q_0 p_0 \log \text{nat } \frac{p_1}{p_0}$, but it is the latter

form which, after substituting the approximate value of $\frac{p_1 - p_0}{p_0}$

for $\log \text{nat } \frac{p_1}{p_0}$, and when disregarding the compressibility of air within small variations of pressure, gives us the equation, $u_c = Qp$.

Referring to Mr. Beard's comment on my Nos. 3, 9, and 10, I must declare that I cannot see that matter in his light. To my mind it is and remains a radical difference.

I fully concur with Mr. Beard when he says that "in any circulation the pressure p varies with the square of the quantity." The quantity Q is proportional to the velocity v in the airway, hence p varies also with the square of v . The resistance (ks^2) of the airway also varies as the square of v . The force applied to the resistance must be proportional to the latter, and hence must also vary as the square of v , or it must be proportional to p . Since double the quantity creates a four-times-greater resistance, the force must also be four times greater. Our force is the centrifugal

force $\frac{W}{g} \times \frac{V_p^2}{\rho}$, which becomes four times greater by doubling V_p , or n . Hence, double the n means double the quantity, or the yield of a fan is proportional to its speed; the pressure varies as the square of the speed. This much for the present, as a denial of Mr. Beard's claim that " Q varies as $\sqrt[3]{n^4}$, and p varies as $\sqrt[3]{n^8}$."

In my No. 5 I have defined $U = m \times f \times \frac{f}{2} = \frac{1}{2} m f^2$ as the work of acceleration of the constant force $m \times f$ when acting upon mass m , during the first second only. Mr. Beard has paid no attention to this limitation of the formula. A brief retrospect will throw an interesting side light upon this phase of our controversy, and will positively dispose of it. In all his papers on this subject, up to date, Mr. Beard says: $U = m f \times \frac{f}{2}$ is the work of

acceleration of the constant force f for each second. Here is how he came to commit this error. At the conclusion of a discussion which he had with Prof. Sperr (Colliery Engineer, August, 1895), he recommends a study of Ganot's "Elements de Physique" (translated by E. Atkinson) and quotes from it: "When a constant force acts on a mass so as to change its velocity, the work done by the force is equal to half the product of the mass into the change of the square of the velocity." Continuing, he says: "The change of the square of the velocity, for a unit of time, would be the square of the acceleration" (evidently construing "the change of the square of the velocity" as equivalent with "the square of the change of the velocity"). The formula which is paraphrased by E. Atkinson in the above language reads $U = \frac{1}{2} m (v_1^2 - v^2)$. It appears at a glance that the factor in

parenthesis, correctly expressed, is "the difference of the squares of the velocities." I am inclined to think that probably the translator is responsible for this inaccurate paraphrase, but I am unable to say so, since the French original is not within my reach. However, I do not understand how Mr. Beard could allow himself to be tripped, with the formula plainly before his eyes. By making use of this formula, we derive the work of acceleration of the constant force mf as follows:

In the first second, $U_1 = \frac{1}{2} m(f^2 - 0^2) = \frac{1}{2} mf^2$. In the second second, $U_2 = \frac{1}{2} m[(2f)^2 - f^2] = \frac{1}{2} m \times 3f^2$. In the n th second, $U_n = \frac{1}{2} m[(nf)^2 - (n-1)^2f^2] = \frac{1}{2} m(2n-1)f^2$.

These results show that the work in the first second is $\frac{1}{2} mf^2$ and that the work in any second exceeds the work in the preceding second by mf^2 .

We can get the same results in another way, namely, when we remember that the work of a force is the force multiplied with the distance through which it is exerted. These products are the factors written in the order in which they are given above:

For the first second, $U_1 = mf \times \frac{f+0}{2}$. For the second second,

$U_2 = mf \times \frac{2f+f}{2}$. For the n th second, $U_n = mf \times \frac{nf+(n-1)f}{2}$.

The work of acceleration is a different one for every second. It cannot be given generally for a second.

Mr. Beard's main equation No. 1 (No. 2 is No. 1 divided by p) has been framed under the above misconception; its general form

$U = \frac{1}{2} mf \times f_1$ has been obtained by substituting $m_1 f_1 = m \times f$ in equation $U = \frac{1}{2} m_1 f_1^2$, it expresses the work of the force m accelerating the mass m_1 in the first second—not in any second. By $m_1 = \frac{pa}{Kq}$ Mr. Beard has tried to represent the mass correspond-

ing to the resistance. To show that and why $\frac{pa}{K}$ does not express the resistance, as I have stated in my No. 4, would take up too much space; but I repeat that $\frac{pa}{K}$ is not the resistance, and introduced as such, it is another distinct element of error in equation No. 1.

When equation 1 and 2 are wrong, any result obtained by combining either with any other equation must necessarily also be wrong. In this manner Mr. Beard has arrived at his " q varying as $\sqrt[n]{n^4}$, and his p varying as $\sqrt[n]{n^8}$."

Mr. Beard has offered no comment on my No. 8. I urge him to read it over again carefully, and in the face of the above disclosure of his errors, I trust he will see the truth of my statements there, and will acknowledge that if $U = F \times \frac{f_1}{2}$, then, according

to the definition of "work," $\frac{f_1}{2}$ must be the distance through which the force F is exerted. As the equation stands, both F and $\frac{f_1}{2}$ are unknown; we only know that their product must be equal to Qp ; we require another equation, to solve the problem.

Mr. Beard's other equation is $\frac{f_1}{2} = \frac{1}{2} \frac{KWV_p^2}{pa\rho}$, which, however, cannot express the distance through which the force is exerted in a second as has been shown and will be further shown, when I shall come to discuss the "fundamental error" in Mr. Beard's theory.

In reply to Mr. Beard's comment on my No. 11, I am free to admit that the efficiency I introduced is a pure assumption. I stated it to be assumed, without giving any reason for my choice. Of course I had a reason. I know, for a fact, that his old formula for K was wrong in principle, and since he does not show the deduction of his present one (equation 4), I have not examined it closer. I am quite skeptical of it, however, as I actually do not believe that such high efficiencies can be attained. The fan actually works as a compressor, and I cannot see how it can attain a higher efficiency than is the rule with the most improved compressors built for that special purpose. I think 0.70 fully as high as can be expected; but to please Mr. Beard, I will also state the result of a rational solution of the example, using his calculated efficiency $K = 0.8392$. With this efficiency the fan would deliver 200,000 cubic feet against a pressure of 6 inches water gauge at about 150 revolutions, and at 100 revolutions it would not deliver anything against that same pressure—in fact, it could not generate that pressure. It could, at 100 revolutions, deliver 200,000 cubic feet against about 2.85" W. G.

In conclusion, I will demonstrate the "fundamental error" in Mr. Beard's theory. I might briefly say: *The work of the fan is not a work of acceleration, because it is work against resistance.*

Ganot says: "When work is being done, the physical part of the process consists solely in producing or changing motion, or in keeping up motion in opposition to resistance, or in a combination of these actions.

"When a ship is sailing at a uniform speed, the force exerted on it by the wind causes no change in its motion, but simply prevents such a change being produced by the resistance of the water; or when a railway train is running with uniform velocity, the force of the engine does not change, but only maintains its motion in opposition to the forces, such as friction and the resistance of the air, which tend to destroy it."

The case of air circulation through a mine is exactly analogous to these two examples.

When a body of air is moving through a mine with uniform velocity (this is the case when a constant quantity of air enters and leaves the mine every unit of time) the centrifugal force developed by the air rotated in the fan does not change, but only maintains the motion of that body of air through the mine. It simply prevents a change being produced by the resistance of the mine; hence the work of the centrifugal force is work against resistance.

The centrifugal force, in doing its work, is exerted through a distance identical with the radial velocity of the air through the "movable ducts" in our air conduit. The "movable ducts" are the fan compartments which the air has to traverse radially at some point in its circuit from the atmosphere back into the atmosphere.

The radial velocity through these "movable ducts" is the quotient $\frac{Q}{a}$, where a , of course, is the cross-sectional area of these ducts.

This constitutes the simple solution of the problem, and I trust it will appeal to the "thoughtful mind" and bring order into "chaos."

Yours truly,
P. J. MARKMANN, C. E.

Chicago, Ill.

Burt Exhaust Head.

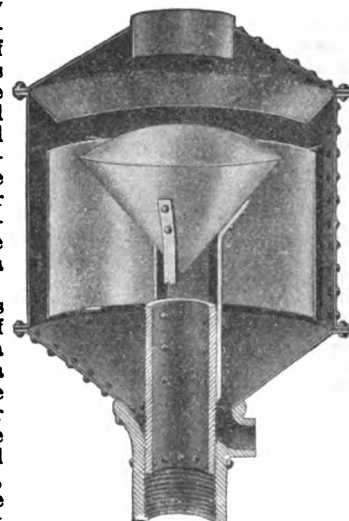
The construction of the Burt exhaust head is well shown in the accompanying figure. These heads, when attached to the exhaust pipe of a boiler system, prevent the escape of oil and wet steam, and thus prevent injury to adjoining property and disfigurement and the rotting of one's own premises, besides saving of water, as the same water can be used over and over again. This condensed water will be free from sediment and impurities, and the fact that it economizes water recommends this device strongly to many mines where the item of water economy is a most important one.

The Burt exhaust head has perpendicular sides instead of conical ones, thus giving it a greater inside area, which area is also not lessened by inside baffle plates, diaphragms, or scrap metal. The head is made of extra-heavy iron, riveted and soldered, and all joints, seams, and attachments are water-tight. The head cannot overload nor blow up, and is covered with anti-rust paint.

The steam going through the exhaust pipe strikes the cone immediately over the mouth of the pipe which separates the steam into fine particles, thus condensing some of the vapor. A greater part of the steam rises up to the small projection extending around the top of the head, where it is held for an instant, and during this time drops of water and oil fall down between the double walls and out through the drip below.

This device is made by the Burt Mfg. Co., of Akron, Ohio, which has 10 years' experience back of it in the manufacture of oil filters and similar steam appliances, rendering its guarantee of particular value.

C. B. Finley, general manager of the Soddy, Tenn., Coal Co., who for a number of years has been in charge of the mining and coke making at Soddy mines, has resigned to accept a similar position with a Louisville, Ky., mining company. He is succeeded by Mr. Wigton, of Pennsylvania.



PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only, and each answer must be numbered to correspond with the question.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Time for receiving answers expires on the first day of the month following publication.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for August.

QUES. 604.—*Preservation of Mine Timber*.—What is the action of creosote in the preservation of mine timber? Describe also the manner in which timber is preserved by charring.

QUES. 605.—*Cutting Mine Timber*.—In what season of the year should mine timber be cut, and why? State all the reasons that you know for and against the cutting of mine timber at such time.

QUES. 606.—*Gravity-Plane Haulage*.—Calculate the size of rope required to lower an output of 1,000 tons per day of 10 hours, over an incline 300 yards long. The upper landing is 50 feet of vertical height above the tippie. Draw a sketch also showing the profile of the incline, from the tippie to the upper landing. Calculate the starting and stopping grades at the head and foot of the incline respectively, and the uniform grade of the incline. Assume a rolling friction of $\frac{1}{4}$ of the normal pressure upon the plane, and the weight and capacity of the mine cars as 1,500 and 2,200 pounds, respectively.

QUES. 607.—*Strike and Dip of Seams*.—Give a clear explanation of what you mean by the terms "strike" and "dip" in reference to inclined seams.

QUES. 608.—*Cleats and Bedding Planes in Coal Seams*.—Explain the terms "cleats" and "bedding planes" in reference to coal seams and other stratified deposits. Also, state if there is any fixed relation between the direction of the principal or face cleats and the inclination of the seam.

QUES. 609.—*Surveying, Precautions Necessary When Surveying With Magnetic Needle*.—What precautions are necessary in surveying with the magnetic needle, in presence of iron or where attraction is liable to exist? State by what means such a survey may be made fairly reliable.

QUES. 610.—*Ventilation, Effect of Splitting the Air Current Upon the Speed of a Fan*.—The power remaining the same, what effect will the splitting of the air current into two equal splits have upon the speed of the ventilator? State the reasons for your answer.

QUES. 611.—*Furnace Ventilation; Splitting, Pressure Constant*. The circulation in a certain mine is maintained by means of a furnace at the foot of the upcast, but the quantity of air is insufficient for the thorough ventilation of the mine. If it were possible in this mine to divide the air current into two equal splits, would the quantity of air in circulation be doubled by this means? Give the reasons for your answer.

Answers to Questions Which Appeared in the June and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 588.—*Loaded Car Derailed*.—A loaded mine car weighing 3,500 pounds has been partially derailed, the rear wheels having left the track, while the forward wheels still remain upon the rail. The length of the car, out to out, is 7 feet; the distance

between the centers of the wheels is 21 inches. What force applied to the end of a 5-foot lever would raise the rear end of the car if the lever has a bite of 2 feet; that is to say, the end of the lever is run 2 feet under the end of the car?

Ans.—The weight of car acting at center of gravity exerts a downward turning moment about the front axle of $3,500 \times \frac{21}{12 \times 2} = 3,062.5$ foot-pounds, to balance which requires a lifting force at end of car of $3,062.5 \div \left(\frac{21}{12 \times 2} + \frac{7}{2} \right) = 700$ pounds. The

reaction of this latter force acting on the lever would produce a downward turning moment about the "heel" of $700 \times 2 = 1,400$ foot-pounds, which is to be overcome by a lifting force P applied 5 feet from "heel," or $5 \times P = 1,400$; whence, $P = 280$ pounds.

A. B. JESSUP, Centralia, Pa.

Second Prize.—CHAS. E. BOWRON, Birmingham, Ala.

QUES. 589.—*Removal of a Body of Gas*.—A large body of gas has been discovered in a number of chambers driven 50 yards to the rise of a gangway. The chambers have been abandoned for some time and their ventilation neglected. Describe the difficulties to be encountered in the removal of this gas, and how the work may be accomplished with the least danger to the men employed in the mine.

Ans.—The difficulties to be encountered in the removal of this gas would be as follows: Owing to there being such a large body, we would have to clear it away block by block, as will be explained; we would also have to repair the headings and restore a proper system of ventilation as we proceeded, which would necessarily make its removal quite tedious and slow.

In proceeding to remove this body of gas, I would select a few experienced, competent men, and equip them with the very best type of safety lamp procurable. If I was foreman, I would take entire charge of the work myself, assisted by my fire boss.

In the removal of a large body of this kind, I would conduct a split of air up outside breast direct from first heading, assuming this to be the main return of the mine. I would conduct air up outside breast to first breast heading or breakthrough by means of the best brattice cloth, or if I did not consider this equal to the occasion, I would erect a board brattice. When I reached first breast heading or breakthrough I would repair it and open it up to its proper size, as in all probability it would be partly or altogether closed if it had been abandoned any length of time; this, of course, would depend upon nature of coal, roof, etc.

After having restored the system of ventilation thus far in outside breast, I would proceed in the same manner in the next breast inside, and so on along the entire group, opening up the headings and restoring a good system of ventilation as I proceeded. After clearing all the breasts to this point, I would then proceed to remove gas from breast up to the next heading in the same manner as before, this time connecting my brattice on the mouth of the first breast heading on the inside, using the same brattice as before, as it would not be needed below. After reaching second breast heading I would open it and repair it same as with first heading. Then I would place a stopping in the first breast heading on outside; this would cause the air current to flow through second breast heading. I would proceed in this manner all along the group of breasts, clearing to second heading or breakthrough.

I would again start in same manner at outside breast and clear to the face which, if worked upon proper system, should have headings along the faces of breasts. I would place stoppings in the headings below, which would cause the air current to sweep the faces of the breasts, thus clearing off all gases immediately.

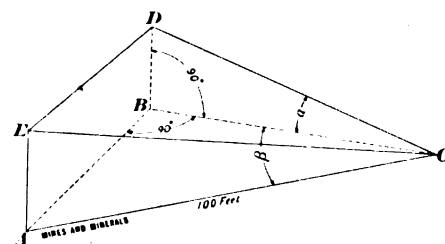
After clearing them I would keep them free by causing an active current of air to circulate through them.

J. W. POWELL, Carbonado, Wash.

Second Prize.—WM. S. DAVIS, Edwardsdale, Pa.

QUES. 590.—*Grade of Slant Road*.—Give a short, concise rule by which to determine the percentage of grade of a road in an inclined seam, when the inclination of the seam and the angle that the road makes with the direction of the dip of the seam is given. Illustrate the rule by the calculation of the grade of a road whose bearing is N 87° 30' W, in a seam having an inclination of 43° 20'; the direction of the dip of the seam being N 60° 50' E.

Ans.—In the accompanying diagram let CD = a line on the



full dip of the seam; BC = direction of the dip of the seam; CE = slant road; CA = 100 feet of the horizontal projection of said slant road; α = angle of inclination of seam; β = angle which the slant road makes with the direction of the dip of the seam.

Then we have: In the horizontal right-angled $\triangle ABC$,

$$BC = 100 \cos \beta.$$

In the vertical right-angled $\triangle BCD$,

$$BD = BC \tan \alpha = 100 \cos \beta \tan \alpha.$$

Since $BD = AE$ = percentage of grade of slant road AE = $100 \cos \beta \tan \alpha$.

Hence the rule: To determine the percentage of grade of a road in an inclined seam, multiply the cosine of the angle which the slant road makes with the direction of the dip of the seam by the tangent of the angle of inclination of the seam and the product thus obtained by 100.

To apply this rule to the example, we have

$$\alpha = 43^\circ 20';$$

$$\beta = 62^\circ 50' + 87^\circ 30' = 150^\circ 20'.$$

Hence, percentage of slant road = $100 \cos 150^\circ 20' \tan 43^\circ 20' = 81.978$ per cent.

THEODORE SIMONS, Roseland, B. C.

Second Prize.—A. B. JESSUP, Centralia, Pa.

QUES. 591.—*Rescue of Men in Case of Fire.*—A certain mine is ventilated by means of an exhaust fan placed a short distance to one side of the main hoisting shaft. The hoisting shaft is a large three-compartment shaft, two of these compartments being used for hoisting, and forming the downcast for the entire mine. The third compartment is connected with the exhaust fan mentioned, and furnishes the upcast shaft for the return current of the mine. Built over the hoisting shaft is a large building used as a breaker, containing the machinery for the preparation of the coal for market. At a distance of 400 yards from the present shaft is an old abandoned shaft which was formerly used as the hoisting shaft for this mine. What danger do you consider is imminent in the present arrangement, and what measures would you suggest be adopted in order to facilitate the rescuing of the men in case of a fire occurring in the breaker?

ANS.—Three dangers confront us in this question: First, smothering of the men, in case of fire, unless the fan is stopped; second, danger of an explosion in the mine, in case the fan is stopped; third, danger of being entombed, by the hoisting shaft becoming filled with burnt timbers.

I would clean out the old abandoned shaft and retimber it if necessary; partition it off, so as to have two compartments. One compartment I would have furnished with proper hoisting machinery and connected with the present intake airway. In the other compartment I would have a duplicate fan erected and connected with the present return. I would have doors so hung that by closing a door on the present intake and opening a door on the intake of the abandoned shaft, and also the same on the returns, that the airways of the present shaft would be completely cut off, and the same opened to the abandoned shaft. I would have the fan and hoisting engines ready to start at all times on a few minutes' notice. In case of fire I would close down the present fan and start the one at the abandoned shaft, close the doors on intake and return between hoisting shaft and abandoned shaft, open the doors on intake and return of abandoned shaft. Then the air would travel on the same course, going down, and returning in the abandoned shaft, which would be far enough away from the fire that no heat nor smoke would be drawn to it. I would send competent men down at once to different parts of the mine, and hurry out the men. Also instruct them to come to the abandoned shaft to be hoisted up.

JOHN N. KING, Uniontown, Pa.

Second Prize.—JOHN W. POWELL, Carbonado, Wash.

QUES. 592.—*Starting a Furnace Fire.*—A deep mine has been closed for a long period owing to the prevalence of a strike. The mine is not gaseous, but it is subject to gob fires which produce large quantities of blackdamp. The only means of ventilation is a furnace, which has not been lighted during the period of the strike, and the mine is full of damp to the top of the shaft. Explain what difficulties would be encountered when the mine is again started, and how you would proceed to start ventilation and light the furnace fire.

ANS.—I would induce ventilation in the shaft by means of a steam jet or waterfall. When the shaft was clear of blackdamp I would go down, build a brattice back of the shaft, closing off all the workings. I would then break open a brattice connecting the return. I would keep on using my steam jet or waterfall and bratticing off parts of the mine until I reached the furnace. Then I would be able to light a fire. After the furnace got well heated and was making a good current I would begin opening the brattices and letting out just as much blackdamp as the furnace could take without cooling the fire. I would clean out one district at a time, opening brattices in front and closing up behind until I had all the mine clear.

JOHN N. KING, Uniontown, Pa.

Second Prize.—JOHN VERNER, Oskaloosa, Iowa.

QUES. 594.—*Cleats in Coal Seams.*—Explain what is meant by the "cleats" and "joints" of the coal, in working coal seams, and what effect these have upon the manner of working at the face.

ANS.—In most coal seams, there are vertical cleavages, or planes of separation, which are called cleats or joints. These cleats occur in two directions, about at right angles to each other. In every instance one or the other of the cleats is more pronounced, and these are called "face cleats," while the shorter joints or cleats are called the "ends" or "butt cleats."

The butt cleats, more often called "joints," are short and broken, and intercepted by the face cleats.

The cleats of the coal are an important factor in determining the method of attack or direction of driving the breasts.

According to the character of the cleats of any seam of coal, breasts should be worked "face on," "end on," "half on," "long horn," or "short horn." Working "face on" is advancing the breast in a direction at right angles to the face cleats. Working "end on" is advancing the breasts in a direction parallel to the face cleats or principal cleats of the coal. Working "half on" is advancing the breast in a direction making an angle of 45° with the cleats. Working "long horn" is advancing the breast in a direction making an angle with the principal cleats greater than 45° . When the direction which the breast advances makes an angle of less than 45° with the principal cleats, it is termed "short horn." Each of these methods has its peculiar adaptation to the varied conditions of the coal seam. For example, when the face cleats are free, that is to say, the coal breaks readily along the face cleats, and the coal is reasonably hard, the "long-horn" method should be adopted.

The reason for this is, that when the coal is undercut it will need more support than it gets from the cleats, and hence its weight must be thrown somewhat upon the end cleats.

The angle of the breast will depend upon the hardness of the coal and the freedom of the cleats. When the face cleats are working free, and the coal is very soft, it may be necessary to drive the breast "end on," that is, in a direction parallel to the face cleats.

This method is best adapted to a very heavy roof pressure. If, however, the roof pressure is light, the "short-horn" method is often adopted, in order to assist in breaking the coal. The "face-on" method of working is adopted when the face cleats are not so free or numerous as the butt cleats. A little thought will make the adaptation of these different methods very clear to one who is conversant with conditions of mining at the face.

Unless the coal at the face receives sufficient support, the undercutting or "bearing in" cannot be done thoroughly, or else the labor of "spragging" is increased, as also the risk to the miner.

The adoption of one or the other of these methods also reduces the cost of cutting or "shearing" to a minimum.

J. W. POWELL, Carbonado, Wash.

Second Prize.—THOS. O'BRIEN, La Salle, Ill.

QUES. 595.—*Size of Sheaves.*—Give a rule for calculating the minimum size of sheaves in rope transmission, when the diameter and kind of material of the rope are given. State what are the stresses upon a rope in passing over a sheave, and how these may be calculated. Assume any load upon the rope and arc of contact of the rope upon the sheave.

[No satisfactory solution has been received.—EDITOR.]

Boilers With Too Much Heating Surface.

An interesting illustration of the well known fact that a boiler can have more heating surface than is good for it, was cited recently by Dr. Coleman Sellers in a lecture before the Franklin Institute. When the first large engines and boilers for the water works of the city of Philadelphia were installed many years ago, it was found, upon test, that the boilers were insufficient for their purpose. Oliver Evans, who had designed the engines, had specified the length of the grate bars and the width of the furnace to be used, as also the length of the boilers, which were of the plain cylinder type; but the wise men of the city government believed that they could do better by making the boilers much longer than he had suggested, and they were so constructed. Upon their failure to do the work, Oliver Evans was sent for in haste to correct the difficulty. His message to those in charge, enforced by his presence afterwards, was that they must cut off 10 feet from the length of each boiler. This seemed a strange proceeding, but he soon explained to them that the extra length which they had added to his prescribed dimensions was acting as a condenser to reconvert steam into water, inasmuch as the heat of the furnace could not extend the whole length of the boilers as they had been built. Upon cutting the boilers down to their proper size so the heat could extend over the whole fire surface, they proved sufficient for their work, and continued to operate as long as this primitive water plant was in existence.

TRADE NOTICES.

The A. Leschen & Sons Rope Co., 920-922 North Main Street, St. Louis, Mo. and 47-49 South Canal Street, Chicago, has recently distributed a very neat souvenir penholder. This is made up to show the patent flattened-strand wire rope made by this company, and known as the Hercules brand.

Fraser & Chalmers, Chicago, have received from the Anaconda Copper Mining Co. orders for a large amount of machinery for their new concentrating plant, which will have a capacity of 4,000 tons per day. This machinery includes 24 heavy pattern 5-foot Huntington centrifugal roller quartz mills, 24 sets of 40 in. $\times$ 16 in. crushing rolls with forged-steel shells, and 24 Blake crushers, sizes 24 in. $\times$ 12 in. and 15 in. $\times$ 9 in.

The Imperial Steel Works, owned and operated by the Japanese Government, has just placed an order for the complete equipment of the plant with Cross oil filters, with the Burt Mfg. Co., of Akron, Ohio. As the Burt Co. were in competition with the best manufacturers of filters in Europe and other American makers, they regard it as a distinct triumph for the Cross filter. The Imperial Steel Works is probably the most important plant of the kind in the kingdom.

The Macomber & Whyte Rope Co. announce that it has purchased the entire interest of Mr. Leschen in the Leschen-Macomber-Whyte Co., and he no longer has any connection with their business nor any authority to act for their company, which will hereafter be known as the Macomber & Whyte Rope Co. The company will continue doing business at the old location, 19 and 21 South Canal Street, Chicago, where it has a large stock of wire rope, the quality of which is well known. The company will continue to carry a complete stock of specialties as heretofore, and all orders in this line will be promptly executed; it will also make a specialty of mine, quarry, and contractors' supplies at the lowest market prices.

The Ericsson Telephone Co., 296 Broadway, New York, have just issued Part 4 of "The Ericsson Series." It contains a diagram of connections for a simple metallic circuit switchboard and some interesting information concerning the number of telephone subscribers in the various large cities of Europe, Africa, and South America. Any one sending his name and address will receive a copy by return mail. The Ericsson transmitters, made in Sweden, are protected by oiled silk, making them especially durable for use in damp places, such as mines. Their transmitters and receivers do not seem to be affected in any way by moisture, heat, or cold, which is not the case with many cheap telephones now on the market.

The *London Times* in its issue of June 8, 1900, devoted considerable space to a description of the E. P. Allis Works, Milwaukee, Wis. The reason for this notice was the fact that this company has recently taken extensive contracts for large engines in England and has thus caused surprise and consternation among the English manufacturers who have hitherto not looked for competition in this line from across the water. To indicate the extent of the plant the writer notes that at the time of his visit to the works there was one order alone for 8 pairs of compound engines of 8,000 horsepower. Another order for 11 sets of engines, aggregating 77,000 horsepower, for the electrical power station which was to supply current for the surface railroads for New York City. At the same time the firm had orders on book for 34 blowing engines. These large orders represented only a part of the work in hand.

It is reported that contracts for building a line of steam railroad for the North Coast & Olanco Valley Railroad Co., recently incorporated, will be let in the early fall. This line will be 40 miles long, and will run from Port Burchard to Eldorado. Mr. Chas. B. Cramp, of Philadelphia, is president and Mr. Chas. S. Putnam, chief engineer. The initial surveys have been completed, and the capital secured for pushing this road to early completion, thus opening up a section of Honduras which should be of great interest to Americans who have been used to thinking of the country more from a mineral standpoint than from an agricultural. Port Burchard, on the north coast of Honduras, is only 5 days out from Philadelphia, which is less time than it takes to go to San Francisco or into the interior of Mexico. The completion of this North Coast & Olanco Valley Railroad will greatly enhance the interests of farming, timber cutting, mining, manufacturing, and colonization.

The Aultman Co., of Canton, Ohio, reports that business is holding up very satisfactorily. Recent orders include a sand-handling system for the foundry of the Massillon Iron & Steel Co., at Massillon, Ohio; two large No. 5 Aultman rock crushers for the Bonnot Co., of Canton, Ohio; one No. 3 Aultman rock crusher

and one car haul for the Page Woven Wire Fence Co., of Monessen, Pa.; one refuse conveyor for the Acker Lumber Co., at Livermore, Ky.; one refuse carrier for the Hall & Lyon Furniture Co., of Waverly, N. Y.; one complete plant for the manufacture of tile and building block for the Beatty Fire Clay Co., of Magnolia, Ohio; one tipple-house equipment for the Indian Run Coal Co., of Canton, Ohio; one complete system of elevating and conveying machinery for handling raw material and finished product at the beet sugar refinery of A. W. Colwell & Co. at Marine City, Mich.; six ingot charging machines for the Wellman-Seaver Engineering Co., of Cleveland, Ohio; and a pulp carrier for the Munroe Falls Paper Co., of Munroe Falls, Ohio.

The Flemington Coal & Coke Co., of Flemington, Taylor County, West Virginia, has installed a complete Morgan-Gardner electric plant consisting of three 150-horsepower Erie boilers; two 150-horsepower Skinner engines; two 100 kilowatt Morgan-Gardner dynamos; and a complete system of haulage, which consists of some seven miles of trolley, two electric locomotives (Morgan-Gardner), and seven mining machines (Morgan-Gardner). Mr. A. L. Simpson, general manager of the Flemington Coal & Coke Co., says: "Our vein is the celebrated Pittsburgh seam, and averages about 9 feet in thickness. So far this machinery seems to be doing very nicely, especially the haulage part of same. As to the chain cutting mining machines, it is a great question whether machines of this type of any manufacture are a benefit in such large veined coal. The miners complain that in consequence of the small amount of space which is left for the coal to drop, after being cut by the machines, that it is almost impossible to mine this coal unless sufficient powder is put into same to blow it all to pieces. In this way the resulting coal runs very high in fine coal and slack, which, according to the claims of the different manufacturers, should be just the reverse. The Morgan-Gardner machines, however, work very nicely and cut well. As this machinery has only been running for a few months, we are not in position at present to state whether we consider electric machinery an advantage or not. It certainly is an advantage in haulage; whether this applies to the cutting of the coal is a question that can only be determined after having given this machinery ample trial."

The Northern Pacific Railway Co. has specified Bethlehem nickel-steel for the driving axles and crankpins for 20 locomotives now under contract with the Schenectady Locomotive Works. The Bethlehem Steel Co. reports that the list of railroads using this material is steadily growing, but calls attention to the fact that those wishing to specify it for locomotive forgings should be careful to designate it as Bethlehem nickel-steel, as the reputation gained by it has resulted in the production of inferior imitations which do not show the same high qualities. The Bethlehem Steel Co. also has in hand the entire equipment of steel shafts and engine forgings which are to go into the new steamer building by the Harlan & Hollingsworth Co., at Wilmington, for the Mallory Line. Also all the shafts and forgings for the 11,000-ton steamer which is to be built by the Union Iron Works, of San Francisco, for account of the American-Hawaiian S. S. Co. In this instance the owners saw fit to specify that all the parts mentioned should be made at the Bethlehem Steel Co. plant, a most gratifying testimony to the good effect of the campaign which has been carried on in favor of a higher standard of material and workmanship in such important features of marine construction. The city engineer of Chicago recently placed with the Bethlehem Steel Co. an order for a hollow-forged shaft to replace a breakdown in the North Side pumping station at that city. The new shaft, which measured 13 feet 8½ inches in length, 19 inches in diameter, and weighed close to 10,000 pounds, was booked on May 30, and, under special emergency instructions, was hollow-forged, annealed, and rough-machined in time to go forward June 9.

PERSONALS.

Mr. Benedict Crowell, of the firm of Crowell & Peck, has recently been in Virginia, examining mining property near Richmond.

The Campbell Coal & Coke Co., of Woody, Tenn., has recently purchased 4,000 acres of land in Cumberland County, Tenn. This tract of land is underlaid by two 5-foot veins of coal, one is a steam and domestic block coal, and the other steam and coking coal. A large force of men is at work developing the mines, and the company expects to ship 1,000 tons per day by December next. The officials of the company are: R. O. Campbell, president; J. B. Campbell, secretary and treasurer, Atlanta, Ga.; and A. W. Schenck, manager, Woody, Tenn.

ELECTRICITY IN MINING.

Principles Governing the Calculation, Construction, and Operation of Electrical Installations.

Dynamos and Motors—Speed Regulation of Motors—Alternating-Current Dynamos—Alternating-Current Motors—Induction Motors—Transformers.

Written for MINES AND MINERALS, by R. B. Williamson.

(Begun in May Issue.)

Speed Regulation of Motors.—The torque of a motor depends upon the current; that is, for a given current, the torque will be the same whatever may be the speed, provided the field strength remains the same. The speed at which the armature runs is a matter of E. M. F. only; that is, with a given current the speed will be proportional to the applied E. M. F., or, more strictly, the counter E. M. F., other conditions remaining the same.

It has been shown that the torque will automatically regulate itself for changes in the load. The speed, however, may be varied by varying the applied E. M. F. or the strength of the field. A change in speed may or may not result in a change in the torque required, depending on the character of the work done by the motor.

The simplest way to vary the applied E. M. F. is to insert a resistance, in series with the armature, similar to the starting resistance. By varying this resistance the applied E. M. F. at the terminals of the motor is also varied, although the E. M. F. of the mains remains constant. It is evident that the energy represented by the product of the current and the drop through the resistance is converted into heat, and is thereby wasted; therefore, for great variations in speed this method is not economical, though often very convenient.

The applied E. M. F. may also be varied by varying the E. M. F. of the generator supplying the current, but this can only be done where a single generator is supplying a single motor or several motors, whose speed must all be varied at the same time; so that this method is only used in special cases.

If the strength of the field is changed the speed necessary to give a certain counter E. M. F. will also be changed, which gives a convenient method of varying the speed. If the strength of the field is lessened the speed will increase, and if the field is strengthened the speed will decrease. With shunt motors the field may be weakened by inserting a suitable resistance in the field circuit, as in shunt dynamos; with series motors the same result may be obtained by cutting out some of the turns of the field coils or by placing a suitable resistance in parallel with the field coils.

This method of regulation is also of limited range, since it is not economical to maintain the strength of the field much above or below a certain density. The resistance method described above being rather more simple, it is generally used. For special cases, such as street-railroad work, various special combinations of the above methods of regulation are used.

One of the most common of these is known as the series-parallel method, and is the method of regulation generally used at present for operating street cars. This method is equivalent to the method of cutting down the speed by reducing the E. M. F. applied to the motor and is only applicable where at least two motors are used. It is also used, to some extent, in haulage plants. When a low speed is desired or when the car is to be

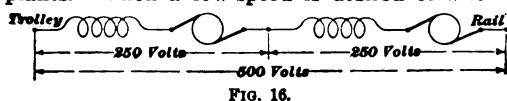


FIG. 16.

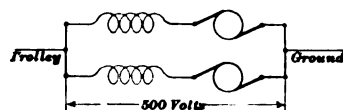


FIG. 17.

and each motor runs at full speed because it gets the full line pressure. In practice, starting resistances are used in connection with the above to make the starting smooth but the two running positions are as shown, the motors being connected in series in the one case and in parallel in the other.

Connections for Continuous-Current Motors.—Fig. 18 shows the manner in which a shunt motor is connected to the terminals + and - of the circuit. It will be seen that the current through the shunt field does not pass through the resistance R which is connected in the armature circuit. This is necessary, since to

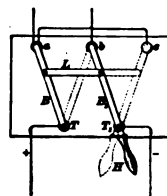


FIG. 20.

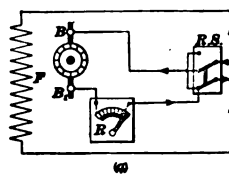


FIG. 21.

keep the field strength constant the full difference of potential must be maintained between the terminals of the field coil, which would not be the case if the rheostat were included in the field circuit, for then the difference of potential would be only that existing between the brushes + B and - B . As on starting the motor this difference of potential is small, only a small current would flow through the field coils, which would generate such a weak field that an excessive current would be required to furnish the necessary torque for starting the motor.

When connected as shown, however, the field is brought up to its full strength before any current passes through the armature, so this difficulty does not arise. Since in a series motor the same current flows through both armature and field coils, the starting resistance may be placed in any part of the circuit. The diagram in Fig. 19 illustrates one method of connecting a series motor to the line terminals + and -; here the starting or regulating resistance R is placed between the - line terminal and the brush - B of the motor. To reverse the direction of rotation of a motor it is necessary to reverse either the direction of the field or the direction of the current through the armature. It is usual to reverse the direction of the current in the armature, a switch being used to make the necessary changes in the connections.

Fig. 20 shows the connections of one form of reversing switch. Two metal bars B and B_1 are pivoted at the points T and T_1 ; one is extended and supplied with a handle H , and the two bars are joined together by a link L of some insulating material, such as fiber. Three contact pieces a , b , and c are arranged on the base of the switch so that the free ends of the bars B and B_1 may rest either on a and b , as shown by the full lines, or on b and c , as shown by the dotted lines. The line is connected to the terminals T and T_1 , and the motor armature between a and b , or vice versa, a and c being connected together.

When the switch is in the position shown by the full lines, T is connected to a by the bar B , and T_1 to b by the bar B_1 . If the switch is thrown by means of the handle H into the position indicated by the dotted lines, T is connected to b by the bar B , and T_1 to a by the bar B_1 , and the connection between c and a . The direction of the current through the motor armature, or whatever circuit is connected between a and b , is thus reversed.

In order to reverse only the current in the armature, the reversing switch must be placed in the armature circuit only. Fig. 21 represents the connection for a reversing-shunt motor (a) and a reversing-series motor (b); + and - are the line terminals; R , the starting resistance; B and B_1 the brushes of the motor, and F , the field coil of the motor. Some manufacturers combine the starting resistance and reversing switch in one piece of apparatus.

In connecting up motors some form of main switch is used to entirely disconnect the motor from the line when it is not in use.

To prevent an excessive current from flowing through the motor circuit from any cause, short strips of an easily melted metal, known as fuses, mounted on suitable terminals, known as fuse boxes, are placed in the circuit. These fuses are made of such a sectional area that a current greater than the normal heats them to such an extent that they melt, thereby breaking the circuit and preventing damage to the motor from an excessive current. The length of fuse should be proportioned to the voltage of the circuit, a high voltage requiring longer fuses than a low voltage, in order to prevent an arc being maintained across the terminals when the fuse melts.

If desired, measuring instruments (ammeter and voltmeter) may be connected in the motor circuit, so that the condition of the load on the motor may be observed while it is in operation. All these appliances, regulating resistance, reversing switch, fuses, instruments, etc., are placed inside the main switch; that is, the

current must pass through the main switch before coming to any of these appliances, so that opening the main switch entirely disconnects them from the circuit, when they may be handled without fear of shocks.

ALTERNATING-CURRENT DYNAMOS.

An alternating-current dynamo is one that generates a current which periodically reverses its direction of flow. It was shown in connection with Fig. 10 that an armature provided simply with collector rings produced an alternating current in the outside circuit. This current may be represented by a curve such as that shown in Fig. 22. The complete set of values that the current or E. M. F. passes through repeatedly is known as a *cycle*. For example, the values passed through during the interval of time represented by the distance *ac* would constitute a cycle. The set of values passed through during the interval *ab* is known as an alternation. An alternation is, therefore, half a cycle. The number of cycles passed through per second is known as the *frequency* of the current or E. M. F.

Alternating-current dynamos are now largely used both for lighting and power transmission, especially when the transmission is over long distances. The reason that the alternating current is specially suitable for long distance work is that it may be readily transformed from one pressure to another. We have already seen that in order to keep down the amount of copper in the line a high line pressure must be used. Pressures much over 500 or 600 volts cannot be readily generated with direct-current machines owing to the troubles that are likely to arise due to sparking at the commutator. On the other hand, an alternator requires no commutator or even collecting rings if the armature is made stationary and the field revolving, as is frequently done. Alternators are now built that generate as high as 8,000 or 10,000 volts directly. If a still higher pressure is required on the line it can be easily obtained by the use of transformers, to be explained later. It is thus seen that where power is to be carried over long distances the alternating current is indispensable.

Alternating-current dynamos, like direct-current machines, consist of two main parts, i. e., the field and armature. Either of these parts may be the revolving member, and in many modern machines the armature or the part in which the current is induced is the revolving member. Fig. 23 shows a typical alternator of the belt-driven type, having a revolving armature. It is not unlike a direct-current machine as regards its general appearance. The number of poles is usually large, in order to secure the required frequency without running the machine at a high rate of speed. The frequencies met with in practice vary all the way from 25 to 150. The higher frequencies are, however, passing out of use, and at present a frequency of 60 is very common. This frequency is well adapted both for power and lighting purposes. When machines are used almost entirely for lighting work, frequencies of 125 or higher may be used. The frequency of any machine may be readily determined when the number of poles and the speed is known, as follows:

$$\text{Frequency} = \frac{\text{number of poles}}{2} \times \frac{\text{rev. per min.}}{60}.$$

For example, if an 8-pole alternator were run at a speed of 900 R. P. M. the frequency would be

$$f = \frac{8}{2} \times \frac{900}{60} = 60 \text{ cycles per second.}$$

Alternators may be divided into the two following classes: (a) Single-phase alternators; (b) Multiphase alternators.

(a) *Single-phase Alternators.*—These machines are so called because they generate a single alternating current (as represented by the curve shown in Fig. 22). The armature is provided with a single winding and the two terminals are brought out to collector rings, as previously described. Single-phase machines have been largely used in the past for lighting work, but they are gradually being replaced by multiphase machines because the single-phase machines are not well suited for the operation of alternating-current motors.

(b) *Multiphase Alternators.*—These machines are so called because they deliver two or more alternating currents that differ in phase, i. e., when one current is, say, at its maximum value the other currents are at some other value. This is accomplished by providing the armature with two or more distinct windings which are displaced relatively to each other on the armature. One set of windings, therefore, comes under the poles at a later instant than the winding ahead of it, and the current in its winding comes to its maximum value at a later instant than the current in the first winding. In practice, the two types of multiphase alternator most commonly used are (1) two-phase alternators, (2) three-phase alternators.

Two-phase alternators are machines that deliver two alternating currents that differ in phase by one-quarter of a complete cycle, i. e., when the current in one circuit is at its maximum value the current in the other circuit is passing through its zero value. By tapping four equidistant points of a regular ring armature, as shown in Fig. 24, and connecting these points to four collector rings, a simple two-pole two-phase alternator is obtained. One circuit connects to rings 1 and 1', the other circuit connects to rings 2 and 2'. It is easily seen from the figure that when the part of the winding connected to one pair of rings is in its position of maximum action, the E. M. F. in the other coils is zero, thus giving two currents in the two different circuits that differ in phase by one-quarter of a cycle or one-half an alternation.

Three-phase alternators are machines that deliver three currents that differ in phase by one-third of a complete cycle, i. e., when one current is flowing in one direction in one circuit the currents in the other two circuits are one-half as great and are flowing in the opposite direction. By tapping three equidistant points of a ring winding, as shown in Fig. 25, a simple three-phase two-pole alternator will be obtained. Three mains lead from the collecting rings.

In order to have three distinct circuits it would ordinarily be necessary to have six collecting rings and six circuits, but this is not necessary in a three-phase machine if the load is balanced in the three different circuits, because one wire can be made to act alternately for the return of the other two.

Uses of Multiphase Alternators.—Multiphase alternators are coming largely into use, because, by using them, alternating-current motors can be readily operated. By using multiphase machines, motors can be operated that will start from rest under load, whereas with single-phase machines the motor has to be brought up to speed from some outside source of power before it can be made to run. For this reason such machines are used for the operation of modern power-transmission plants. As far as

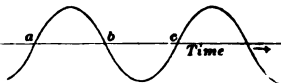


FIG. 22.

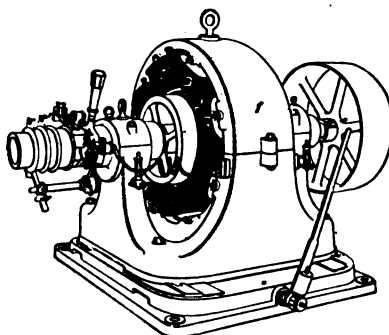


FIG. 23.

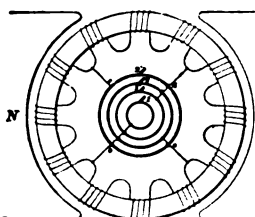


FIG. 24.

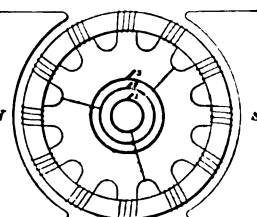


FIG. 25.

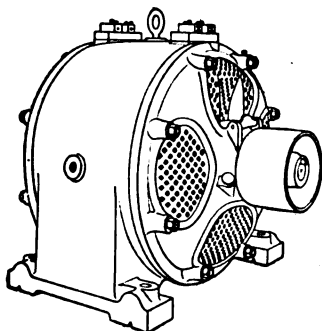


FIG. 26.

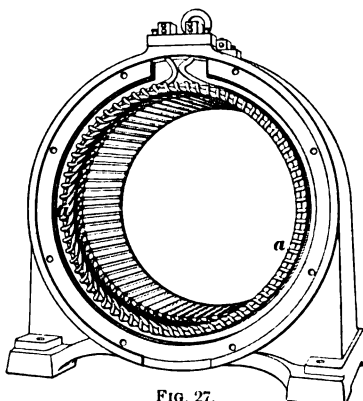


FIG. 27.

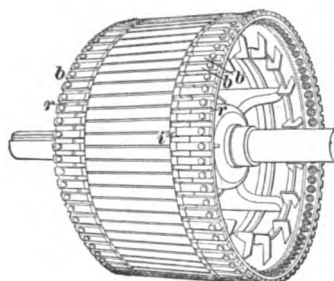


FIG. 28.

the general appearance of three-phase machines goes they are similar to ordinary single-phase alternators, the only difference being in the armature winding and the larger number of collector rings. The multiphase alternator is also adapted for the operation of lights, so that by using these machines both lights and motors may be operated from the same plant. They are well adapted for power-transmission purposes in mines, especially for the operation of pumping and hoisting machinery, because the motors operated by them are very simple in construction and therefore are not liable to get out of order.

ALTERNATING-CURRENT MOTORS.

Alternating-current motors may be divided into two general classes: (a) Synchronous motors; (b) Induction motors.

(a) *Synchronous motors* are almost identical so far as construction goes with the corresponding alternator. For example, a two-phase synchronous motor would be constructed in the same way as a two-phase alternator. They are called synchronous motors because they always run in synchronism, or in step with, the alternator driving them. This means that the motor runs at the same frequency as the alternator, and if the motor had the same number of poles as the alternator it would run at the same speed no matter what load it might be carrying. This type of motor has many good points, and is especially well suited to cases where the amounts of power to be transmitted are comparatively large and where the motor does not have to be started and stopped frequently. Multiphase synchronous motors will start up from rest and will run up to synchronous speed without aid from any outside source. They will not, however, start with a strong starting torque or effort, and will not, therefore, start up under load and cannot be used in places where a strong starting effort is required. For this reason synchronous motors are not suitable for intermittent work.

(b) *Induction motors* are so called because the current is induced in the armature instead of being led into it from some outside source. Fig. 28 shows a typical induction motor. There are two essential parts in these machines, viz., the field into which multiphase currents are led from the line, and the arm-

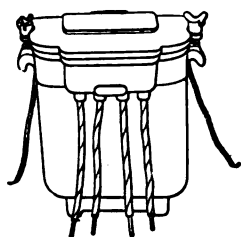


FIG. 30.

to the line, is stationary. Fig. 27 shows the construction of the stationary member or field. This consists of a number of iron laminations built up to form a core and provided with slots around the inner periphery. The form-wound coils constituting the field winding are placed in these slots and connected to the mains. This winding is arranged in the same way as the armature winding of a multiphase alternator. When the alternating currents differing in phase are sent through the winding, magnetic poles are formed at equidistant points around the periphery of the field, and the constant changing of the currents causes these poles to shift around the ring, thus setting up what is known as a revolving magnetic field. This armature, Fig. 28, consists of a laminated iron core provided with a number of slots, in each of which is placed a heavy copper bar *b*. The ends of these bars are all connected together by two heavy short-circuiting rings *r, r* running around each end of the armature. The bars and end rings thus form a number of closed circuits. When such an armature is placed in the revolving field the magnetism will cut across the armature conductors, inducing E. M. F.'s in them, and since the conductors are joined up into closed circuits, currents will flow in them. These currents will react on the field, and the armature will be forced to revolve. Such an armature will not run exactly in synchronism, because if it did it would revolve just as fast as the magnetic field, and there would be no cutting of lines of force. The speed drops slightly from no load to full load, but if the motor is well designed this falling off in speed is slight.

Induction motors possess many advantages for mine work. One of the chief of these is the absence of the commutator or any kind of sliding contacts whatever. Such motors can, therefore, operate with absolutely no sparking—a desirable feature for mine work. The motors are also very simple in construction, and are, therefore, not liable to get out of order. They

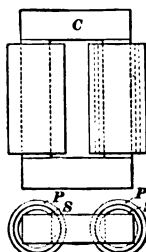


FIG. 29.

have an additional advantage over the synchronous motor in that they start up with a strong starting effort, and, in fact, behave in most respects like any good shunt-wound direct-current motor. They are used for all kinds of stationary work, such as pumping, hoisting, etc., but have not been used to any great extent for haulage purposes. When these motors are used for purposes where a variable speed is required, it is customary to provide the armature with a winding similar to that of the field and bring out the terminals to collecting rings so that resistance may be inserted in the armature circuit.

TRANSFORMERS.

One of the principal reasons for the fact that continuous current is giving place so largely to alternating current is the ease with which the latter may be transmitted over long lines at high voltages, and then be transformed at the receiving end to currents of lower pressure suitable for operating lights, motors, or other devices. If power is to be transmitted over long distances, it is absolutely necessary that high line pressures be employed, in order to make the cost of the conductors reasonably low. Reference has already been made to the use of transformers for changing an alternating current from a higher to a lower pressure, or, vice versa, with a corresponding change in current. Transformers used for raising the voltage are known as *step-up* transformers; those used for lowering the pressure are known as *step-down* transformers.

The transformer consists of a laminated iron core upon which two coils of wire are wound. These coils are entirely distinct, having no connection with each other. One of these coils, called the *primary*, is connected to the mains; the other coil, called the *secondary*, is connected to the circuit to which current is delivered. Fig. 29 shows the arrangement of coils and core for a common type of transformer. The secondary coil is wound in two parts *SS'*, and the primary coil, also in two parts *PP'* is placed over the secondary. *C* is the core built up of thin iron plates. Fig. 30 shows a weatherproof cast-iron case for this transformer. When a current is sent through the primary it sets up a magnetism in the core which rapidly alternates with the changes in the current. This changing magnetism sets up an alternating

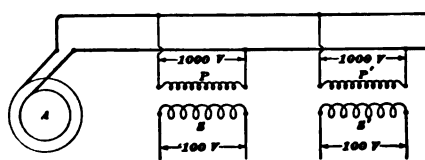


FIG. 31.

E. M. F. in the secondary, and this secondary E. M. F. depends upon the number of turns in the secondary coil. If the secondary turns are greater than the primary, the secondary E. M. F. will be higher

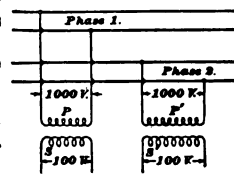


FIG. 32.

than that of the primary. The relation between the primary E. M. F. and secondary E. M. F. is given by the following:

$$\text{Secondary E. M. F.} = \text{primary E. M. F.} \times \frac{\text{secondary turns}}{\text{primary turns}};$$

or,

$$\text{secondary E. M. F.} = \frac{\text{primary E. M. F.}}{\frac{\text{primary turns}}{\text{secondary turns}}}$$

The ratio $\frac{\text{primary turns}}{\text{secondary turns}}$ is known as the ratio of transformation of the transformer. For example, if a transformer had 1,200 primary turns and 60 secondary turns its ratio of transformation would be 20 to 1, and the secondary voltage would be one-twentieth that of the primary. Transformers are made for a number of different ratios of transformation, the more common ones being 10 to 1 or 20 to 1. Of course a transformer never gives out quite as much power from the secondary as it takes in from the primary mains, because there is always some loss in the iron core and in the wire making up the coils. The efficiency of transformers is, however, high, reaching as high as 97 per cent. or 98 per cent. in the larger sizes. Transformers are always connected in parallel across the mains, and, if they are well designed, will furnish a very nearly constant secondary pressure at all loads when furnished with a constant primary pressure. Fig. 31 shows transformers connected on a single-phase circuit; Fig. 32 shows the connection for a two-phase circuit; and Fig. 33 shows one method of connection for a three-phase circuit.

Transformers are usually set up in moisture-proof and fire-proof iron cases on poles or attached to the outside of buildings. Sometimes they are placed in subcellars or vaults within the buildings. The cases are sometimes filled with oil to ensure good insulation.

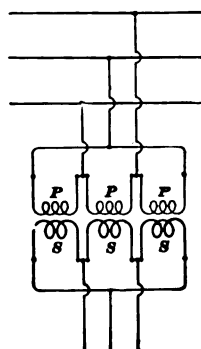


FIG. 33.

(The End.)

ARGO OR NEWHOUSE TUNNEL.

The Purposes for Which It Is Being Driven and the Method of Driving.

A Comparison of the Length and the Methods of Driving This Tunnel and Some of the Other Large Tunnels Which Have Been Driven in Past Times.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

By far the largest and most important of the tunnel enterprises in Colorado is the Newhouse or Argo tunnel at Idaho Springs. This tunnel, which has been many years in progress since its inception, has at last borne fruit, and within the past few weeks has come into prominent notice by a remarkable strike it has made at the end of over 1½ miles of tunnel work. We visited the tunnel a few days after the strike and found its general development, though vastly lengthened, but little differing in detail from when we examined it in 1895. A big tunnel once begun is, as a rule, carried on with monotonous regularity and similarity of detail to near its completion.

As the Newhouse tunnel is one of the greatest tunnel enterprises of the West, and we may say, of the world, especially from a miner's point of view, it is interesting to compare it with others in both hemispheres, that have preceded it, and to compare notes as to the rapidity of progress and facilities derived from inventions which make the modern tunnel such a very different enterprise from those of past years.

Amongst great tunnel enterprises we may mention the Nequehoning, Musconetcong, Hoosac, and Sutor tunnels, in America, and the Mt. Ceniz and St. Gothard, in Europe. The Rothshönberger Stollen tunnel, in Saxony, is an example of old-style work and of German perseverance, and the Sutor, of more modern appliances.

The Sutor tunnel is so well known to all American mining men that we shall only touch upon a few points so far as they have a bearing on the Newhouse.

The tunnel is in the Washoe Range, Storey County, Nevada. It was early considered that it would be an advisable thing to tap the lode at a great depth by tunnel. Before the tunnel everything was raised to the surface by steam power.

In 1860, A. Sutor conceived the plan of driving a deep tunnel to the Comstock lode. In 1865 the Legislature granted a franchise of right of way. The other companies working on the Comstock agreed to pay a toll of \$2 per ton on every ton of pay ore after the completion of the tunnel. The legal rights given the tunnel are interesting for comparison with those which have lately been formulated on tunnel enterprises.

Congress, by the Sutor Tunnel Act, gave Sutor:

1. The right of way to run a tunnel seven miles long to and beyond the Comstock lode, and a north and south drift on this vein and all others found on the line of tunnel.
2. The right to sink shafts on the line of the tunnel, and to purchase public land in connection with the tunnel at \$1.25 per acre.
3. The right of acquiring at \$5 per acre all veins occurring inside a distance of 2,000 feet from the tunnel, except those already in possession of other parties.
4. To levy a royalty on mine owners in consideration of the drainage and other advantages on the completion of the tunnel.

Between 1860 and 1878 the Comstock produced \$291,341,026. Its total product up to date is over \$325,000,000.

Sutor's scheme was to make the tunnel a main artery from which branches should extend throughout the entire mining district, which has a width of 8,000 feet and a length of five to seven miles. This was to be crosscut at intervals and recross-

cut, thus finding all bodies of ore in the district, also to supply cheap transportation, drainage, and other facilities. The tunnel, starting from Carson Valley, penetrates the rock 20,000 feet and strikes the lode near the middle of its productive portion, 1,900 feet below its highest outcrop.

The rocks encountered were hornblende, andesite, augite, andesite diabase, diorite. The greatest depth reached by shaft was 3,000 feet. Intense heat prevails in the lower levels and much hot water is found there. In July, 1878, connection was made with the Savage vein and mine at 20,000 feet, and a strong draft set in at once; in September, 1878, another mining drift was encountered, and in October a third. In January, 1879, connection was made with four more shafts. In September, 1872, the first attempt at machine drilling was made, and 542 feet of holes drilled in 30 days by the Burleigh drill. Dynamite was first used in 1870. Six drills were used in the face.

The Sutor as typical of the introduction of the new style and appliances, and the Rothshönberger Stollen, of the old style, are worthy of comparison.

The latter was commenced in Saxony, in 1844, and opened in 1877. All but the last few hundred feet were driven by hand labor without any of the modern appliances. The best average was 279 feet per month. The length is 42,366 feet. The deepest point reached was 308 feet below the surface. With all its branches completed there will be about 31 miles of tunneling. The longest tunnel in the world. The cost up to 1874 was \$1,500,000 or about \$51 per running meter. This long tunnel gains a depth of only 308 feet below the Anna mine adit, and

connections with other mines give a drainage of only 499 feet. The object of this tunnel is the same as that of the Sutor, which is five miles long, and meets the workings nearly 2,000 feet below the surface. If the economical Germans can spend so much money and time in making an adit 30 miles long for the sake of gaining a depth of 300 feet drainage, it is evident that the days of deep tunnels are not over.

In Utah they have driven a tunnel four miles long to drain by a few hundred feet the celebrated Ontario silver mine, and this through the hardest limestone and quartzite.

The Argo or Newhouse Tunnel.—Idaho Springs is both a watering place and a mining town on the South Fork of Clear Creek. Central is a strictly mining town, high in the mountains, five miles north of Idaho Springs. These two camps are the center of a little strip of country four miles by five, which since 1859 has produced over \$80,000,000, principally gold.

Around Central there are 10 mines which have passed the million-dollar mark. There are 5 to 10 shafts reaching a depth of from 1,200 to 2,200 feet, and 20 mines ranging in depth from 700 to 1,200 feet. In consequence of the excessive cost of pumping and hoisting, the working of some of these mines has been temporarily abandoned. In view of the fact that Idaho Springs, on the main stream of Clear Creek, four miles from Central, is 1,100 feet lower in altitude, it was simultaneously determined by various parties to run long tunnels at a slight grade, practically from the line of railroad below and above Idaho Springs, in the direction of the rich mines, and by tapping them from below not only to drain them automatically but to take out the ore by natural gravity to the railroad tracks. The first and foremost of these is the Newhouse tunnel, whose total length will be 4½ miles.

A poor dirty stream supplies water to the mines and mills of Central, quite inadequate to their wants, whilst the South Fork, at Idaho Springs, is a powerful stream throughout the year.

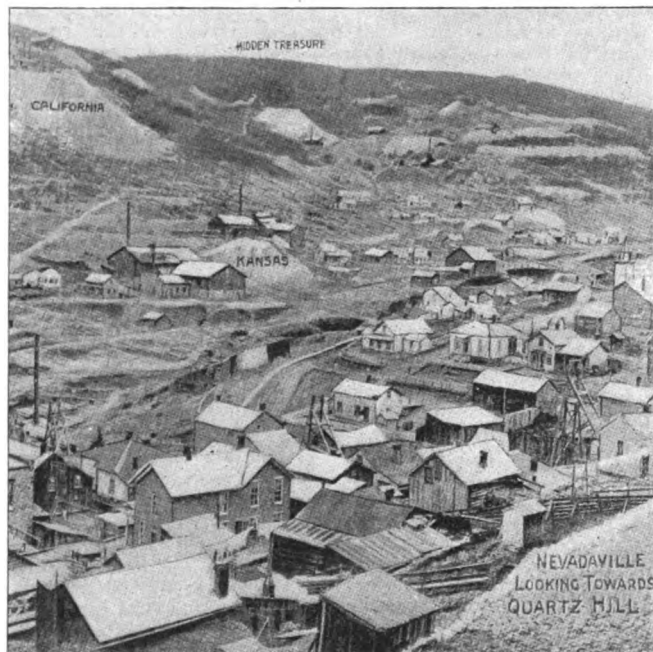
On the southern face of this region, ascending from Idaho Springs, the surface is steep and mountainous, diversified by ravines and culminating on the summit of Pewabic Mountain, several thousand feet above the river below. From this a fine view both of the mines of Central and Idaho Springs is obtained. From summit to base the mountain slope is dotted both with mine openings and prospect holes, following certain roughly parallel lines indicating the outcrop of a series of parallel fissure veins. These veins the Newhouse will cut at considerable depth at right angles to their general strike or direction; the greatest depth



TIMBERING NEWHOUSE TUNNEL.

attained will be 3,000 feet. The tunnel is 12 feet wide by 12 feet high, and is now in 8,500 feet.

From the top of this mountain, forming the dividing ridge between the two mining districts, we look north on a country of rolling hills and open valleys, continuing as far as the Cañon of



NEVADAVILLE. NEAR CENTRAL, CAL.

the North Fork, along whose banks are strung out the mining towns of Nevadaville, Central, and Black Hawk; towns whose streets are undermined by mining tunnels and shafts, while the noise of ore crushing mills, ill supplied with water fills the air, indicating active mining in the vicinity. This section of Gilpin is even more honeycombed with mines and prospects, and dotted with mining dumps and shaft houses than the vicinity of Idaho Springs, impressing one with the fact that the whole region is underlaid by a vast network of gold and silver veins, many of which have produced ore continuously for the past 30 years.

The geology is simple, consisting of a country rock of mica schist and gneiss, traversed by numerous dikes of porphyry and pegmatitic veins. In the general uplift a series of more or less parallel fissures were formed, extending some miles across country, and descending to depths far below the reach of mining operations. These fissures were filled with quartz and feldspar veins, carrying certain amounts of gold and silver ores, principally the former.

The experience of 30 years has shown in the deepest mines, such as the California, which is over 2,200 feet deep, that richness rather increases with depth than otherwise, and that both increase in size and value in depth has been remarkably shown in the late strike on what is believed to be the "Gem" or "mother vein" in the Newhouse tunnel itself.

The great number of mineral veins in this region is shown by the section of those already well known and developed veins that lie in the pathway of this tunnel. There are 1,400 patented claims in Gilpin County alone, with a large number on the Idaho Springs side. There are doubtless many others concealed by debris and brush. These blind veins will become the property of the Newhouse tunnel in its deep workings. Their development will add to the development of the tunnel.

The Newhouse will undermine, at an average depth of nearly 2,000 feet, a mountain $3\frac{1}{2}$ miles in diameter traversed by an unusual number of parallel fissure veins carrying more or less gold and silver, the richness of many of which has already been satisfactorily proven. The purpose of the tunnel is to discover, crosscut, drain, and operate at greater depths than otherwise feasible, lodes of gold and silver, and to offer working facilities to mines discovered hitherto, and to offer an outlet and milling facilities to all at a minimum cost.

The arrival of the tunnel at or rather beneath the mines will be an enormous help to them, especially in getting rid of the water with which they are at present overburdened. Thus it is estimated that, while 36 leading mines have produced \$53,000,000 they have expended over \$8,000,000 in pumping and sinking 73,000 feet of shafts. One mine for years raised on an average 40

tons of water for every ton of ore and rock. An appalling accident in the Cook and Sleepy Hollow mines, of Central, will illustrate the dangers to be averted by the arrival of the Newhouse tunnel. Sixteen miners lost their lives; the water of one mine, long pent up, breaking into two other mines. The Newhouse drainage tunnel would have prevented this.

The tunnel will cut through virgin ground in an old mining region of wide extent and reputation, a number of lodes yielding pay ore at great depths. It will afford the cheapest method of working these mines. Thousands of tons of low-grade ore, now lying idle in the mines and dumps will be handled at profit by this tunnel subject to its tariff. Enormously expensive machinery, now operated by steam at great cost, will be no longer needed. Great shafts to accommodate pumping and hoisting machinery will be no longer necessary. A natural ventilation and drainage system for the district will be established, subject to tariff, and lucrative to the Argo Co., in connection with drainage already in the Newhouse. Although only a few veins have been cut and none as yet developed, yet a perceptible diminution of water is already experienced in many of the mines on the hill above, and water is pouring down copiously in what is supposed to be the Gem vein just cut. The approach to a vein in the tunnel is generally heralded by a copious supply of water pouring in.

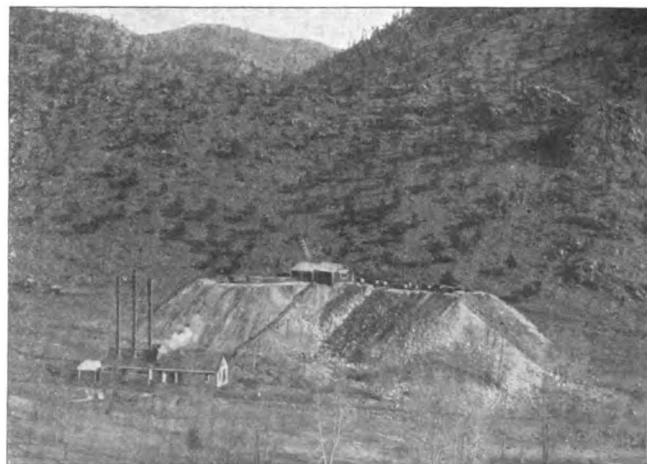
The following notes, descriptive of the construction of the tunnel, were given me by Mr. Walter H. Wiley, engineer in charge:

The tunnel is 12 feet wide by 12 feet high, with double track of 18-inch gauge and a space of 30 inches between tracks. Beneath this central space is a wooden drain, 2 feet wide and 14 inches deep, the top of the drain even with the top of the ties forming a foot path. This box, as the flow of water was at first small, was utilized to convey the foul air out by means of an exhaust fan at the entrance of the tunnel. Since this, and at present, the foul air is carried out by a pipe, 19 inches in diameter, through the medium of a No. 7 Root exhaust blower, with capacity of 12,000 cubic feet per minute, connected with the breast of the tunnel by 19-inch steel air pipe.

The exhaust blower is located in the engine house at the outlet to be described later.

The first 80 feet are timbered with square 10-inch timber, forming an arch overhead. For the rest of the way the rock is so firm and massive that very little timber is required. The rails weigh 30 pounds per yard, and are laid on ties $7\frac{1}{2}$ feet long, which in one side are laid with the end close to the rail to allow room for an open side drain.

The grade is 5 inches in 100 feet. At intervals of about 1,000 feet, short crosscuts are run in the sides of the tunnel, to which the timber men retreat when blasting takes place, and in the one nearest the heading is the battery with which the shots are fired. The character of the rock is gneiss and schist much banded with mica or hornblende, crossed at times by large pegmatitic veins, sometimes passing into mica schist, at others into a very tough, hard black hornblende rock. Several dikes of porphyry have been crossed, and a number of small veins showing mineralization, and in the last few hundred feet several larger mineralized



DUMP AND POWER HOUSE OF NEWHOUSE TUNNEL.

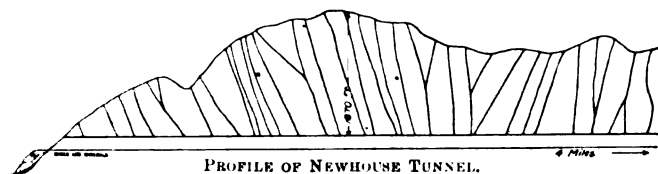
veins, including the last, known as the "big strike" or what is supposed to be the Gem or mother vein. The tunnel is now in 8,500 feet.

The straight line of the tunnel is maintained by a surveyor, who has wooden plugs with screw eyes driven in the exact center line of the roof. By alignment with lamps suspended from these

points, the exact center is determined in the heading every day. This point being determined, the workmen at the face have a vertical central line down the heading and commence work on either side of this. The drilling is done with two 3 inch cylinder Leyner power drills working day shift only. Trimming of dirt is done by the night shift only. The holes are 19 in number, drilled five on either side of the central line, and four or five nearer the sides of the tunnel. The first holes converge inward, and the central core is blasted out first, taking out a wedge-shaped mass of rock.

Drilling is commenced with a short bull drill about 2 feet long, the point 2½ inches diameter; longer drills follow, the point of each of less diameter than the preceding one, drilling a hole shaped like a telescope looking toward the eyepiece. The center cut holes are 8 to 10 feet long, the side ones 6 to 8. Dynamite is used, 100 to 175 pounds each round. The half-pound sticks of dynamite are lowered into the hole as many as 16 sticks at a time, and firmly tamped by a piece of gas pipe with a wooden plug in the end. The 9-foot holes are filled 6 feet deep with dynamite, and the remainder of the hole to the top is filled with cartridges of fine dirt ready prepared. Prior to the tamping the exploder is inserted firmly imbedded in a stick of dynamite. This exploder is a small copper cap about 1 inch long filled with fulminate of mercury. To it are attached two fine copper wires, one negative, the other positive, both thoroughly insulated with a rubber covering. These wires came out of the drill hole at the side of the tamping. The wires for the different holes are united, then one on each side is connected with the main leading wires from the battery. The last 50 feet of the main wire are of a smaller and cheaper kind, and most of this is destroyed at the explosion.

The battery stands safely in a short crosscut some hundreds of feet from the heading, and to this crosscut the men retreat before each explosion. When all are under cover the arm of the battery is raised, rapidly lowered, and all the holes connected are exploded simultaneously. Previous to this the drills are removed to a place of safety. The powder smoke fills the recess and the men wait a few minutes before returning to the heading.



The powder smoke is rapidly sucked out by the indraft of the exhaust fan through the 19-inch pipe. So strong is this draft that a fringe of smoke may be seen hovering on the edge of the pipe, descending it and none of it transgressing the line where the pipe's mouth is. After the center core is cut out, the side rounds are blasted, and then a gang of men immediately begins to clear out the broken rock, which is trammed out to the dump in train loads drawn by mules. In all 21 men are employed, divided into one shift of drill men and two shifts for handling the rock.

On a visit to the tunnel we leave Idaho Springs and walk about half a mile down Clear Creek to the huge dump which occupies several acres on the flat of the creek. A large acreage has been secured for the vast amount of dump matter that will be drawn from the excavation of the tunnel.

We enter the power house, where we see the formidable machinery of the Newhouse tunnel, consisting of two 16 × 16 Norwalk compressors; three 80-horsepower boilers. The No. 7 Root exhaustor is a huge machine, capacity 12,000 cubic feet per minute, connected with the breast by a long steel pipe of 19 inches diameter, carrying the air. The exhaustor has a 50-horsepower direct-connected engine; it can either blow or exhaust by means of valve switches in the pipe. The fan blades of the exhaust weigh 9,000 pounds.

The hot-water heating boiler in the miners' changing room conveys hot water through a circulating system into the powder-warming room, some 50 feet away, keeping powder at even temperature for use. It is heated by return coil of pipes with steam. Five 3-inch drills are used. The blacksmith-shop forge is driven by a waterwheel and blower, using the water which comes from the tunnel. Ore bins are being prepared at the bottom of the dump to carry 1,000 tons of ore; which at present comes from the new strike.

We enter the tunnel on a small Brunton bicycle car moving on the rail. There are larger cars carrying a number of men. We speed rapidly along to the face of the tunnel at a distance of 8,500 feet from the entrance. Here the men are putting in the holes 8 feet deep for the blast, as we have described. Just before

reaching this point we pass under a copious shower of water, descending from the side of the new vein lately struck. The vein is blackened with powder smoke, so we can form little idea of its detail characteristics. Here and there we knock off pieces of compact smelting ore of fine-grained galena and copper pyrite. We are told that the vein, supposed to be the Gem or mother vein of the district, is upwards of 50 feet wide, that streaks of smelting ore are found throughout the mineralized body, and between the streaks of smelting ore are bodies of milling ore. The pay ore is estimated at from 30 to 40 feet in width.

Last week the foot wall was struck, and now the hanging wall is found, showing the vein to be about 50 feet wide, dipping about 70° to the northwest into the mountain.

The Newton mill is now treating the concentrating ore taken out in the crosscutting. In addition to over 100 tons of this mineral, about 15 tons of smelting ore were also marketed. This ranges in several classes of net values of \$50 to \$80 per ton. The mill ore will run \$10 to \$15 a ton, concentrating 4 tons into 1. It being lead, copper, and iron, free from zinc, the system of treating with gigs, screens, and Wilfley tables, makes a saving of every particle of value in which the gold and silver are found.

The present strike is made 2,000 feet below the surface. Work will commence immediately on the vein, the lode will be timbered on both sides and drifted on for 200 feet. Owing to the great width of the ore body it will be a problem how best to handle the vein above, for it is already crumbling. Iron pillars may be used instead of the usual wooden columns. The drift will be at first extended on the hanging wall, leaving the ore body between as a pillar.

The black oxide of copper assays \$20 per ton. In an upper working the average value of smelting ore was \$60 per ton, sometimes \$150 to \$200.

W. E. Renshaw owns the Gem and a number of claims on the line of the tunnel, and in addition is working several others under lease and bond.

The shaft of the Gem extension in the surface was sunk 600 feet, and drifts extended on both sides. From this ground there has been a production up to this time of \$1,000,000. The Main Trunk claim lies on the west, and it is this part of the group where the larger bodies of ore have been cut. It is the intention to raise on the vein at a point 180 feet east of the tunnel line, and at the same time sink a shaft. The strike made in the tunnel means millions additional capital for this section. It has proved the existence of the smelting ore at a depth of 2,300 feet.

The Prevention and Removal of Scale in Steam Boilers.

There is no subject in connection with the use of steam of so much importance as that of the prevention of deterioration of boilers from the injurious effects resulting from an accumulation of scale on the interior surfaces, and from the feedwaters containing chemical ingredients, which attack the iron, producing some one of the numerous forms of corrosion, and to which cause, no doubt, are due many disastrous explosions, entailing great loss of life and property. The Red Seal Boiler Compound, made by the Cherry Chemical Co., 1215 Filbert Street, Philadelphia, Pa., is a chemical preparation that has been used for many years by more than twenty thousand representative establishments throughout the United States and Canada. It is claimed that it neutralizes the acids in feedwaters, and that it prevents and removes scaly deposits, without in any manner injuring the material of the boiler.

This compound is manufactured dry, in the form of a granulated powder, in appearance resembling common brown sugar, and is put in half barrels, barrels, and casks weighing 100 to 1,000 pounds, for the convenience of large and small consumers. It readily dissolves in water, and can therefore be applied in a dry state through the manhole, or in a liquid state by the feed pump. The quantity for an application will depend upon the nature and amount of water evaporated.

The makers claim that when this compound is used honestly and strictly according to the directions, it will never fail to meet the most sanguine expectations of the purchaser, but being composed of chemicals which are harmless to boiler material, its action may require a longer period than would be needed by many other compounds which, while removing the scale, likewise destroy the boiler iron by their corrosive action.

This compound has been endorsed by professional men, by authors of mechanical books, by engineers in charge of works, practical chemists, professional inspectors, and manufacturers having large capital invested in steam boilers. This endorsement, according to the manufacturers, is due to the fact that not a single accident has occurred to any boiler using this compound, although they are to be found in every steam-using locality from Canada to Mexico, and from Maine to the Pacific slope. No stronger recommendation of its merits can be given.

THE METALLURGY OF ZINC.

The Physical Properties—The Chemical Properties. Zinc Ores—Methods of Reducing the Ores.

The Dry Processes—Wet Processes—Electrometallurgical Process—Processes in Which Zinc is Obtained in the Form of an Oxide or Pigment.

Written for MINES AND MINERALS, by H. Van F. Furman E. M.

The production of zinc in the United States has increased enormously in the past 10 years. The production in 1889 was 58,860 short tons, whilst the production in 1898 was 115,399 short tons. The production for 1899 has been estimated at 135,796 tons. The next few years will probably witness a still further increase in the production. In view of these facts a brief résumé of the methods in vogue for the extraction of zinc from its ores may be of interest to the readers of MINES AND MINERALS.

THE PHYSICAL PROPERTIES OF ZINC.

Color and Fracture.—The color of zinc is white, having a bluish-gray tint. It crystallizes in the isometric system. It possesses a high luster on the freshly fractured surface, the nature of the fracture depending upon the temperature at which the fluid metal was cast.

Specific Gravity.—This depends somewhat upon the temperature of the fluid metal at the time of casting and upon the rate of cooling. For ordinary commercially pure zinc it may be considered as 7.15, which is increased to 7.30 by rolling.

Melting Point.—The melting point of zinc is 415°C . Its boiling point is variously stated at from 891°C . to $1,040^{\circ}\text{C}$. Zinc vapor condenses at between 415° and 550°C .

Effect of Impurities.—Commercial zinc generally contains lead, cadmium, iron, and carbon; small quantities of tin, copper, arsenic, and sulphur are sometimes present. Chlorine has been found in some commercial zinc.

Lead renders the metal tender and unfit for rolling. With $1\frac{1}{2}$ per cent. of lead it can be rolled without cracking, but the resulting plates are soft and tender. A greater amount causes the plates to crack, and also causes the film produced in galvanizing to scale off in patches.

Cadmium occurs in most commercial zinc, but as it is more volatile than zinc it is present only in small quantities which have no injurious effect upon the properties of the zinc.

Iron is usually present in small amounts. In fact, in good commercial zinc, the percentage of iron present rarely exceeds 0.18, which small amount does not affect the properties of the metal. Larger amounts render the metal hard and unfit for rolling.

Commercial zinc almost invariably contains small amounts of carbon, which have no influence on the nature of the metal.

Some zincs contain small amounts of tin. If present to the extent of 1 per cent. the metal is brittle and unfit for rolling.

Small quantities of arsenic and antimony are frequently found in commercial zinc, but the small amounts usually encountered have apparently no effect upon the properties of the metal. Sulphur is seldom present. In such minute quantities as have been found it apparently has no effect on the properties of the metal.

Copper is seldom present. When the zinc contains $\frac{1}{2}$ per cent. of copper it becomes harder and brittle, showing cracking and ragged edges on rolling.

THE CHEMICAL PROPERTIES OF ZINC.

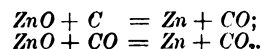
Zinc is not affected by dry air at ordinary temperatures. When the air contains moisture and carbonic acid, the surface of the metal is changed (corroded) to hydrated basic zinc carbonate.

Zinc heated in the air to redness (about 500°C .) burns with a light greenish-blue flame to zinc oxide. It decomposes water at a red heat, giving rise to zinc-oxide and hydrogen gas.

Zinc dissolves in most acids. When dissolved in dilute hydrochloric or sulphuric acids, hydrogen gas is evolved. Impure zinc dissolves more rapidly than the pure metal, owing to electrolytic action, and the greater surface which is exposed to the action of the solvent. Aqueous alkaline solutions dissolve zinc with the evolution of hydrogen, but the solvent action of alkalies is slower than that of acids.

Zinc precipitates all of the heavy metals, except iron and nickel, from their solutions in the metallic state. Zinc is not precipitated from its solutions in the metallic state by any metal which is stable in the air at ordinary temperatures.

Zinc unites with oxygen to form one compound, namely, zinc oxide (ZnO), which is itself infusible and unaffected at ordinary temperatures, but is volatile at a white heat. Zinc oxide is reduced to metal by carbon and carbon monoxide at a bright red heat; thus,



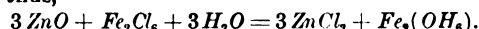
When zinc oxide is heated with carbon (coal or coke) to its reducing point, zinc is first reduced by the carbon. The carbon monoxide formed itself reduces oxide of zinc and is converted into carbonic acid CO_2 . Zinc is oxidized by carbonic acid giving rise to zinc oxide and carbon monoxide. So long as there is an excess of red-hot carbon present the carbonic acid has no oxidizing effect upon the reduced zinc as it is immediately reduced by the carbon to carbon monoxide; hence, in the distillation process an excess of carbon is added, so that some undecomposed carbon remains after its completion. These reactions are of the greatest importance as nearly all of the spelter of commerce is produced by processes which depend upon the above chemical facts.

At a red heat, hydrogen reduces zinc oxide, but the resulting water vapor again oxidizes more or less of the zinc.

Both zinc and zinc oxide, when heated together with sulphur, are attacked, zinc sulphide being produced. Zinc can be completely converted into a sulphide by fusion with alkaline sulphides.

At high temperatures zinc oxide unites with silica to form silicates and with alumina to form aluminates. The present large loss of retorts is mainly due to this. Zinc oxide melts with fixed alkaline carbonates to fluid, colorless slags when the proportion of carbonates to zinc oxide is five or more to one.

Zinc oxide is dissolved by an aqueous solution of ferric chloride; thus,



When finely divided zinc sulphide is subjected to a red heat in the air, zinc oxide, zinc sulphate, and sulphur dioxide are formed. When the temperature rises to a cherry red, the zinc sulphate is decomposed into sulphur trioxide, sulphur dioxide, oxygen, and basic zinc sulphate; as the temperature approaches a white heat the basic zinc sulphate is decomposed, giving rise to zinc oxide, sulphur trioxide, sulphur dioxide, and oxygen. These reactions are of importance, as upon them depends the successful roasting of sulphide ores (zincblende).

Zinc sulphide when heated with carbon and lime gives rise to zinc and calcium sulphide; the reaction is, however, incomplete. At a bright red heat iron decomposes zinc sulphide.

Zinc silicate strongly heated with carbon and lime is almost completely reduced.

Zinc carbonate is reduced to metallic zinc when heated to the reduction point of zinc oxide, together with carbon or carbon monoxide.

Zinc sulphate when slowly heated to redness with carbon is converted into zinc oxide; at a higher temperature the zinc oxide is reduced to metal. If the zinc sulphate is heated rapidly to whiteness in the presence of carbon, zinc sulphide and carbon monoxide are formed. Zinc sulphate or chloride in solution are decomposed by the electric current, zinc going to the cathode and the acid radical to the anode.

Zinc forms alloys with many metals. Some of these alloys, notably those of zinc and copper, and zinc and tin, are of considerable commercial importance. Zinc forms alloys with silver and gold, and has a greater affinity for the precious metals than lead has. Upon this fact an important process (Parks) for the extraction of gold and silver from base bullion (lead-bullion) is based.

ZINC ORES.

Zinc ores generally occur associated with lead ores and frequently with pyrites and marcasite. Thus the blendes of the Upper Mississippi Valley, of Missouri, and Kansas are generally associated with galena, whilst the blendes of the Rocky Mountain States are generally complex ores carrying galena, iron and copper pyrites, and frequently gold and silver. There are a few exceptional deposits in the United States where the ores are free from lead. The vast zinc deposits of Franklin Furnace and Ogdensburg, N. J., are of this character, and carry minerals (franklinite, willemite, and zincite) which are elsewhere considered as rarities. The zinc ores of Friedensville, Pa., consist of blende and its oxidation products, calamine and smithsonite, and are entirely free from lead, although a little pyrite occurs with the blende. At Hanover, New Mexico, there are deposits of smithsonite, calamine, and blende free from lead; but the blende frequently carries pyrites and the oxidized minerals are sometimes stained with manganese.

Blende is by far the most important ore of zinc, as it is the most abundant. It is found in all parts of the world, and in most geological formations. The other zinc minerals are sometimes of local importance as ores.

Zincblende or Sphalerite (ZnS).—Color: wax-yellow, brownish-yellow, to black, sometimes green, red and white. Streak: white to reddish brown. Luster: resinous or waxy, sometimes sub-metallic. The mineral is brittle and has a hardness of from 3.5 to 4 and a specific gravity of from 3.9 to 4.2. Its composition (when pure) is zinc 67 per cent. and sulphur 33 per cent.; but the black variety (marmatite), common to the Western States, contains iron sulphide. The ore is usually associated with other sulphides, as pyrite, marcasite, galena, etc., and gangue minerals, as quartz, calcite, barite, etc.

Zinc Silicate or Calamine ($Zn_2SiO_4 + H_2O$).—Color: white to whitish, sometimes bluish, greenish, or brownish. Streak: uncolored. Luster: vitreous or subpearly. The mineral is transparent to translucent, is brittle, has a hardness of 4.5 to 5, and a specific gravity of 3.16 to 3.9. Its composition (when pure) is zinc oxide 67.5 (zinc 53.7) per cent., silica 25 per cent., and water 7.5 per cent. It is generally found associated with other oxidized zinc minerals, especially smithsonite, and gangue minerals. It is an important ore of zinc at Altenberg, Germany; in Sardinia; in Spain; and occurs in numerous localities in the United States associated with the oxidized zinc minerals and also with blende.

Willemite (Zn_2SiO_4).—Color: whitish, greenish yellow, apple-green, flesh-red, yellowish brown. Streak: uncolored. The mineral is brittle, transparent to opaque, has a hardness of 5.5, and a specific gravity of from 3.89 to 4.18. Its composition (when pure) is zinc oxide 72.9 (zinc 58) per cent., and silica 27.1 per cent. It is an important ore of zinc at Altenberg, Germany, and in New Jersey.

Franklinite [$3(FeZn)O + (FeMn)_2O_3$].—Color: iron-black. Streak: dark reddish-brown. It is a brittle mineral having a hardness of from 5.5 to 6.5 and a specific gravity of from 4.85 to 5.1. It is attracted by the magnet. Its composition varies somewhat but the pure mineral contains from 11 to 21 per cent. of zinc. It is an important ore of zinc and manganese at Franklin Furnace, N. J.

Red Oxide of Zinc or Zincite (ZnO).—Color: deep or bright red. Streak: orange-yellow. Luster: brilliant, subadamantine. Translucent or subtranslucent. Its hardness is from 4 to 4.5 and its specific gravity from 5.4 to 5.7. Its composition (when pure) is zinc 80.3 per cent. and oxygen 19.7 per cent. It is quite abundant in New Jersey and occurs sparingly as an oxidized product in the upper portions of many zinc deposits.

Zinc Carbonate or Smithsonite ($ZnCO_3$).—Color: impure white, sometimes green or brown. Streak: uncolored. Luster: vitreous or pearly. Subtransparent to translucent. It is brittle and has a hardness of 5 and a specific gravity of from 4.3 to 4.45. Its composition (when pure), is zinc oxide 64.8 (zinc 52), and carbon dioxide 35.2 per cent.; but it is usually found associated with the carbonates of cadmium, iron, manganese, lime, and magnesia, and with clay and iron oxide. It occurs in the upper decomposed or oxidized portion of many veins and was formerly an important ore of zinc.

GEOGRAPHICAL DISTRIBUTION OF THE ORES OF ZINC.

Zinc ores are found in many parts of the world; but localities where ores occur sufficiently pure and rich in zinc to permit of the economical extraction of the metal, under existing conditions, are limited.

In Europe, the chief localities are: Germany (the Harz, the Erzgebirge, Silesia, Upper Silesia, Rhine districts, Westphalia, and Baden), Austro-Hungary (Bohemia, Carinthia, Hungary, and Tyrol), Italy (Sardinia, Lombardy, and Piedmont), Belgium (Corphalie and Engis), Russia (Poland, Allagin, and the Donetz Basin), Spain (Satander, Grenada, Carthage, Almeria, and Castillon), Greece, England (Wales, Cornwall, Cumberland, Isle of Man, Anglesea, Denbighshire, and Shropshire).

In Africa (Algeria), Australia (New South Wales), Tasmania, Siberia (Altai), South America (Huanchaca), Mexico, Canada, and British Columbia extensive deposits of zinc ore have been discovered.

In the United States, zinc ores are very widely distributed, but zinc mining is carried on at comparatively few places.

In the eastern section the mines adjacent to Franklin Furnace, N. J., the mines of the Saucon Valley, Pa., and the mines of Wythe County, Virginia, are the only localities of commercial importance at present. (For a description of these deposits see *The Ore Deposits of the United States*, by J. F. Kemp.)

The Upper Mississippi Valley region produces considerable zinc, the principal deposits being found in Southwest Wisconsin, Eastern Iowa, and Northwestern Illinois. These ores are associated with galena and frequently with a little pyrites. (For a description of these deposits see a paper by Dr. W. P. Jenney, in *Transactions American Institute of Mining Engineers*, Volume XXII.)

The bulk of the spelter product of the United States is at present derived from the ores of Southwest Missouri and Eastern

Kansas. The ores are zincblende and subordinate galena with their oxidized products, associated with chert, residual clay, calcite, and small quantities of pyrite. (For a description of these deposits see the reports of the Geological Survey of Missouri.) A small quantity of zinc ore is also produced in Central Missouri, Kentucky, and Tennessee.

Numerous deposits of complex sulphide ores, carrying more or less zincblende, occur in the Rocky Mountain region (Colorado, Utah, Montana, New Mexico, and Arizona). On the Pacific slope complex sulphides carrying zincblende have been opened in Nevada, California, Oregon, and Washington. Although small shipments of zinc concentrates have been made from some of these deposits, and whilst considerable zinc-lead pigment is produced at Cañon City, Colorado, from complex ores, up to the present time the production of zinc from these sources has been insignificant. The blende is almost invariably associated with galena and pyrites, and the ores usually carry considerable gold and silver intimately associated with the various sulphide and gangue minerals.

THE EXTRACTION OF ZINC FROM ITS ORES.

The following are the various methods which are in operation or have been proposed for the extraction of zinc from its ores. In addition to the methods described a number of schemes have been proposed and patented, but so far they have not been adopted on a commercial scale. So far as the commercial production of spelter at present is concerned the dry process is the only one of importance, nearly all of the metal of commerce being produced in this way.

1. *Dry Processes.*—Belgian, Silesian, and Belgo-Silesian methods.
2. *Wet Processes.*—Generally a combination of a wet or chemical process and the dry distillation process.
3. *Electro-metallurgical Processes.*
4. *Processes in which the zinc is obtained in the form of oxide or pigment.*

As metallic zinc cannot be separated from its solutions by any of the metals which are stable at ordinary temperatures the wet methods resolve themselves into a combination of a wet process in which the metal is generally obtained in the form of oxide, which has to be reduced by a dry process, or in a solution from which the metal is precipitated electrolytically.

Preliminary Operations.—Before the ore is subjected to the extraction process it generally has to undergo a preliminary treatment. This preliminary treatment may comprise one or more operations, according to the object to be attained.

The ore may be associated with, or contaminated with, particles of gangue, which have to be removed by dressing or concentrating operations. The ore may be a complex sulphide having quartz, pyrites, and galena associated with the blende. Such an ore would require at least the partial removal of the galena and pyrites before it could be profitably subjected to the dry extraction processes in vogue at present. At Franklin, New Jersey, the ore consists of franklinite, willemite, and zincite in a gangue which is principally calcite. The franklinite is valuable for its zinc and manganese contents when it is separated from its associated minerals. The willemite and zincite together constitute a valuable ore of zinc when separated from the franklinite and gangue, largely on account of the remarkably pure spelter which their reduction produces. This complex problem has been solved in a unique and most satisfactory manner by the introduction of the Wetherill magnetic concentrating machines* which separate the franklinite from the other minerals. The willemite and zincite are subsequently separated from the gangue on ordinary jigs. Carbonate ores carrying calamine must be subjected to a preliminary calcination to drive off the combined water and carbonic acid before they are subjected to the distillation process. They also frequently contain clay, iron oxide, and silica, which have to be removed by dressing before the material is subjected to the distillation process; it not being, so far, profitable in the United States to treat material carrying much less than 55 per cent. of zinc. Sulphide ores must be subjected to a preliminary calcination or roasting to drive off most of the sulphur and to convert the zinc into an oxide, or a mixture of oxide and sulphate. Before the ores can be subjected to the dressing or roasting operations they must undergo a preliminary crushing and pulverizing. Want of space forbids a discussion of these preliminary operations in the present article, and the reader is referred to the writer's previous articles on crushing, concentration, and roasting. (See *MINES AND MINERALS* for November and December, 1896; January, April, May, June, July, and August, 1897; and April, May, and June, 1898.)

DRY PROCESSES OF EXTRACTION.

The methods which have been adopted up to the present time depend upon the property of carbon and carbon monoxide

* *Transactions American Institute Mining Engineers*, Volume XXVI, page 351; also *The Mineral Industry*, Volume VI, page 677.

to separate metallic zinc from oxides and silicates of zinc at a high temperature. The oxidized ores in which the zinc is present as oxide or silicate are suited to direct reduction. Carbonate ores require preliminary calcination, and sulphide ores require a preliminary oxidizing roasting to convert the zinc into oxide. The reduction of zinc begins below the boiling point of zinc (a moderate red heat), but is only complete at a temperature approaching a white heat. Hence, the temperature must be increased to a point above the boiling point of zinc, the metal being separated in the gaseous state and being subsequently condensed to liquid metal. As zinc vapor is oxidized by air, water vapor, and carbonic acid, the gaseous zinc must not come into contact with these gases. The zinc vapor is only condensed between definite limits of temperature (415°C. and 550°C.). If the temperature falls below 415°C. the metal is condensed in the form of zinc fume or blue-powder, and if the temperature rises above 550°C. the metal remains in the gaseous state. This necessitates great care in the selection of the carbonaceous material to be mixed with the ore as a reducing agent, for should it contain too large a proportion of readily volatile matter the gases will drive out the zinc vapor too rapidly to allow of its complete condensation, thus making a great difference in the percentage of extraction. These facts render the extraction of zinc one of the most difficult and imperfect of modern metallurgical operations. The high temperature required for the reduction necessitates the use of first-class and expensive refractory materials for the reduction apparatus. This reduction apparatus consists of closed fireclay vessels

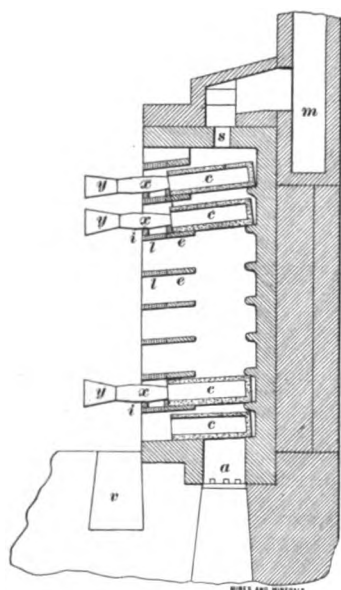


FIG. 1. CROSS-SECTION BELGIAN FURNACE.

which generally have the form of tubes or muffles. The capacity of these vessels is not great, and as they are liable to rapid destruction their cost is high. There is always a considerable loss of metal in the distillation process (from 10 to 30 per cent. of the zinc contents of the ore) as the material of the retorts always retains some zinc combined as aluminate, and some zinc invariably remains in the residues; but principally owing to imperfect condensation of the zinc vapors. Additional losses are caused by defective retorts and condensers.

The various dry processes which have been used on a commercial scale up to the present time are as follows:

English Process or Distillation per Descensum.—This method was introduced at Bristol, England, by John Champion in the year 1740. The oxidized zinc ore was mixed with carbon and heated in large fireclay crucibles. The

crucibles were 4 feet high and $2\frac{1}{2}$ feet wide on top, having an opening in the bottom to which a sheet-iron pipe, 6 inches in diameter and passing through the bottom of the furnace into the vault below, was attached. The lids of the crucibles were cemented on so as to make a tight joint. The zinc vapor, as it was liberated from the ore, descended and was condensed in the iron tube. The method was wasteful and expensive and has been entirely abandoned.

Carinthian Process.—This was similar to the English method except that fireclay tubes were employed instead of crucibles; the lower part of the tubes projected through the furnace bottom and the vaporized zinc condensed here. The process has been entirely abandoned.

Belgian Process.—This method, which was introduced in 1810, has grown in favor until the greater portion of the spelter of commerce is produced by this process. It is the only process in commercial operation in the United States at the present time for the production of spelter.

One of the older forms of Belgian furnace is shown in the illustrations (Figs. 1 and 2), which present a cross-section through the retorts, and a front elevation showing a few of the retorts in place. Fig. 3 is a side view of a single retort in position. The flames generated by the combustion of the coal on the grate *a* travel up and around the retorts *c*, ascending in the shaft of the furnace, and escape through the ports *s* out of the furnace and into the stack *m*. To the retorts *c* are attached the conical fireclay adapters *x* in which the zinc vapors are condensed. To the adapters are attached the sheet-iron nozzles *y* in which the zinc fume is caught. The common practice in the United States is to

substitute for these nozzles simply a handful of the next ore charge, slightly moistened, through which all vapors must percolate before escaping into the outer air. This is more simple and is said to be more efficient than the use of nozzles. The retorts are supported at the rear end by the firebrick projections *b*, Fig. 3, and at the front end by the fireclay slabs *e* of the front wall of the furnace. The cast-iron plates *l* form the continuation

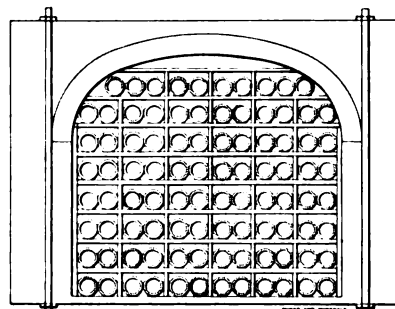


FIG. 2. FRONT ELEVATION BELGIAN FURNACE.

of these slabs, and the firebricks which serve to support the adapters *x*. The retorts are arranged in from six or seven rows above each other, so that most of their outside surface will be surrounded by the flames. The furnaces are either single furnaces with one shaft, or double furnaces built back to back, with two shafts separated by a vertical

partition wall. The number of retorts per furnace varies from 50 to over 400 (the larger number being only practicable in gas-fired furnaces), according to the dimensions of the furnace. According to the method of firing which is adopted, the furnaces may be classified as follows: Furnaces fired by grates, furnaces fired by grates and gas, furnaces fired by gas. The gas-fired furnaces, which are heated by producer gas, have been largely adopted of late years, especially in the United States. They present the advantages, as compared with direct-fired furnaces, of being independent of the nature of the fuel, and, consequently, being adapted to very inferior coals, of consuming less fuel, of consuming fewer retorts, and of extracting a higher percentage of zinc. The gas-fired furnaces may or may not be provided with regenerators. Although regenerator furnaces consume less fuel and attain higher temperatures, they are not largely employed in the Belgian process on account of the regenerator flues becoming choked with zinc oxide, on account of the difficulty of keeping the heat uniform in the high Belgian furnace which results in the retorts becoming overheated, and also on account of their high first cost. With the low and broad Silesian muffle furnace, gas-fired regenerator furnaces have proven satisfactory and economical. In the United States, furnaces fired by natural gas have been extensively adopted in the past few years. At Iola, Kansas, furnaces fired by natural gas have 350 retorts on a side or 700 retorts to each furnace, there being a central partition wall which divides the furnace and extends to the flat reverberatory arch on top. There is one stack at the end of each furnace to carry off the products of combustion. The iron gas mains and the blast pipes which convey the air under pressure for the combustion of the gas, pass over the arch of the furnace. By this arrangement both the gas and air are preheated before their introduction into the furnace. The retorts are arranged in six tiers and there are four gas jets between each double vertical row of retorts. At this works Ropp straight-line furnaces are employed to roast the ores prior to their distillation. The roasting furnaces are also fired by natural gas. Furnaces fired by natural gas present all of the advantages of furnaces fired by producer gas, with the additional advantage of a very cheap fuel. In fact, at Iola, natural gas is furnished to the zinc smelters free of charge.

The retorts used in the Belgian furnace are either cylindrical or elliptical tubes. The material of which the retorts and the receivers or adapters are composed is a mixture of fireclay and burnt clay, or burnt clay and quartz, or a mixture of fireclay and pulverized pieces of old retorts. Sometimes fine coke is mixed with the fireclay.

The proportions of the various materials vary according to their quality and also according to the nature of the ores to be treated in the vessels. The retorts vary in size, the walls being from $\frac{3}{4}$ inch to $1\frac{1}{2}$ inches in thickness, the internal diameter is from $7\frac{1}{2}$ to $8\frac{1}{2}$ inches, and the length varies from 3 feet 3 inches to 4 feet 9 inches. When the cross-section is elliptical the long axis

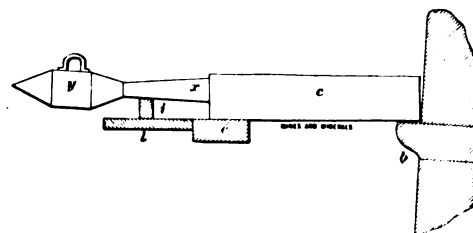


FIG. 3.

is 8½ inches to 12 inches, and the short axis is 6½ to 8 inches in the clear. Larger retorts, which are rectangular in cross-section and have the following dimensions: length, 5 feet; height, 20 inches; width, 9 inches; have been employed. The length of the retorts is limited on account of their being supported at their extremities, and, hence they must carry their own weight and also the weight of the charge without bending or breaking. The retorts were formerly made by hand, but in most modern plants they are now made by machines, which are operated by hydraulic pressure. These machines are similar to those used in the manufacture of sewer pipe. The materials for the retorts are first crushed by means of edge runners or disintegrators, and are then kneaded to a uniform mass with the addition of about 8 per cent. of water. The raw clay, which constitutes about 50 per cent. of the mixture, is ground to a fine flour, whilst the burnt clay and the fragments of old vessels is ground to pass a 4- or 5-mesh screen. The kneading is accomplished in a pug mill, and after the mass is thoroughly kneaded it is stored for from six to eight weeks, to render it more plastic. After moulding, the vessels are air dried for about three weeks and are then dried in heated chambers for two or three months. The temperature of the drying chambers is at first 25° C. and it is gradually increased to 70° C. After drying, the vessels are heated in kilns, the temperature being brought up to a red heat during the last 12 hours. In starting up a new furnace the dried retorts are put in place and burned in the furnace itself. With an old furnace the retorts are heated in the kilns to a red heat and introduced into the furnace in that condition.

Before a furnace is put into operation it is fired gently for some days with empty retorts in place. When it has become thoroughly dried and heated the retorts are charged and the heat is increased gradually. The charges are prepared for reduction by mixing or grinding the ores with coal, no fluxes being added. When a variety of ores are obtainable they should be mixed so as to produce a purely siliceous or a purely basic charge; bases such as iron and lead which form fusible compounds being excluded. If this is impossible they should be so mixed that the bases and the silica will form a slag as infusible as possible at the reduction temperature of the zinc. The reducing agent is lean (non-gaseous) coal, small coke, or a mixture of the two. The amount of reducing agent varies somewhat according to the nature of the ores. For calcined smithsonite and calamine it amounts to from one-third to half the weight of ore, according to the zinc contents. For calcined blende it amounts to from 40 to 50 per cent. of the weight of calcined ore. The blende should be pulverized to pass at least a 14-mesh screen. The calcined oxidized ores being more readily reduced need not be so finely pulverized. The mixing of the ore and the reducing agent is accomplished by hand or, in large works, by separate crushing of the ingredients of the charge and then mixing mechanically. The charges are introduced into the retorts, after removal of the adapters, by means of a semicylindrical scoop attached to the end of an iron rod. The first charges are light, the weight of charge being gradually increased, until, at the end of about five days, normal charges and conditions are attained. These retorts, which are subjected to the highest temperature, receive the heaviest charges. The retorts which are subjected to the lower temperatures are charged with substances which are readily reduced as zinc fume, and zinc-bearing residues, and with ores which sinter readily. The average charge for a retort is about 63 pounds of ore. After the retorts are charged the adapters are attached, the joint being luted with a mixture of loam and coal dust. Some little time after charging, a flame of burning gases escapes from the adapters, and this flame in time changes to the brilliant flame of burning zinc vapor. The nozzles, when used, are now attached to the adapters in order to avoid loss of zinc. Although the adapters soon attain the necessary temperature no fluid zinc condenses in them at first, in consequence of the carbonic acid and water vapor present in the first gases which convert the zinc into oxide. Zinc fume is also largely produced at this stage on account of the greatly diluted condition of the vapors. It is only after the water vapor and carbonic acid cease to be given off that the zinc vapors condense to liquid zinc. The temperature of the furnace must be closely watched, for if too high a temperature is attained, large quantities of zinc fume will be produced, owing to the imperfect condensation of the vapors in the adapters. The condensed zinc is generally removed from the adapters several times during the operation or, occasionally, only once after its completion. In the latter case the nozzles are removed and the zinc is drawn out of the adapters with a scraper. It is drawn into ladles, its surface is skimmed, and it is cast into slabs weighing from 40 to 45 pounds each. The time required for distillation varies from 12 to 24 hours and depends upon the size of the retorts and the furnaces, upon the location of the retorts in the furnace, upon the reducibility of the charge and largely upon the quality of the fuel used. When distillation is finished the adapters are removed and the retort residues are drawn out with scrapers which remove the bulk of the material, the balance being

blown out with a steam jet which serves to clean the retort more effectually than is possible with scrapers.

The total charge of a furnace depends upon the number of retorts which it contains, and varies from 1,000 pounds to several tons of ore. The consumption of fuel depends upon the method of firing adopted and the quality of the coal, varying from 1½ to 2½ tons per ton of ore treated. The life of the retorts depends largely upon the quality of the materials used and their method of manufacture; retorts made of good material and by hydraulic pressure, have an average life of about 40 days. With a modern furnace the loss of zinc seldom exceeds 10 to 12 per cent. With furnaces provided with retorts holding on an average 63 pounds of ore, one man is required for 28 retorts for each shift of 12 hours. The consumption of fireclay, including that used for retorts, adapters, and firebrick is about 400 pounds per ton of zinc product.

(To be Continued.)

The Reduction of Freight Rates.

It is well known that a large part of the price of iron and coal, as delivered to the consumer, represents cost of freight from the mines to the markets, and cost of handling the material; therefore a reduction of this cost has seemed to be a promising point of attack for reducing prices. A recent article in regard to how this reduction may be effected, written by J. T. Odell, vice-president of the Pittsburgh, Bessemer & Lake Erie Railroad, for the *New York Evening Post* says:

It is within the memory of the older railway managers when the capacity of the freight cars was 8 tons, the weight of the rail 50 pounds to the yard, the weight of locomotives 36 tons, the capacity of the bridges 2,000 pounds rolling weight to the lineal foot, and the speed of passenger trains about 30 miles per hour. Within the short period of 35 years the capacity of the cars has been quadrupled, the weight of the rail nearly doubled, the locomotives increased in weight two and one-half times, the carrying ability of the bridges increased two-fold. These striking improvements of the permanent way, motive power and rolling stock have borne great fruit in rendering possible the reduction in the last 16 years of the freight rates from 33 to 50 per cent. These accomplished results render it, therefore, reasonable to suppose that the time is coming when such low ocean rates will become permanently practicable, as will insure a constant export of our surplus products with a fair remuneration to shippers and carriers.

Railway managers are greatly agitated over the question of "ton-mile cost," which means, of course, the question of the relative spread between dead weight and paying load of the freight trains. Probably 55 per cent. of all the weight hauled by the locomotives of the freight trains is dead weight, and only 45 per cent. paying load. This spread makes too great a "ton-mile cost." It is out of proportion to the freight rate, and the percentages must be reversed. This is what all the roads are striving to attain, but it means heavy expenditure for a great many of them. The average paying load of all the freight trains of the country is probably less than 200 tons, which means, of course, a greater "ton-mile cost" than the probable coming export rate will stand. This partially explains the rehabilitation of railroads now going on.

Few people outside of the immediate vicinity of Pittsburgh have the slightest conception of the enormity of the railroad tonnage drawn to and from that center, and an investigation of its traffic affords a fine field for the transportation student and will broaden him. The tonnage of the Carnegie Steel Co., alone, raw material and finished product (being 16,000,000 tons last year) is as great as the combined tonnage of the Northern Pacific, Union Pacific, and Missouri Pacific Railways, embracing as they do more than 18,000 miles of track, and running probably 1,500 locomotives and 50,000 freight cars. A few years ago the steel company became satisfied, after careful investigation, that, if a portion of their tonnage was separated from the general freight of the railroads, concentrated on a road controlled by their own company and handled in solid trains, the cost of transportation could be materially reduced and the reduced rate be remunerative to the railway. With this object in view, they secured a road of their own, running from their mills to their own docks at Conneaut on Lake Erie, a distance of 153 miles. The result of the operation of this railway shows as follows:

The lowest rate per ton per mile, the highest average length of revenue haul in proportion to its track mileage, the greatest density of tonnage in proportion to its freight-train mileage, the greatest average paying load, and the lowest "ton-mile cost" of any road on the American continent reporting to the Interstate-Commerce Commission. The average paying load of all its freight trains, including three branches, and with but little back-loading, was, for the year ending December 31, 1899, 777 tons. It is confidently expected when the south and north-bound tonnage is 70 per cent. and 30 per cent., respectively, and the tonnage reaches 5,000,000 tons annually, as it promises, that the average paying load will be not less than 900 tons, or four and one-half times greater than the present average paying load of the country. The maximum weight of the paying load for the year was 1,580 net tons, with the average as before stated of 777 tons. Of the ore trains, each earned on a 3½-mill rate per ton per mile (gross ton) \$5.13 per train mile. The road is laid with 100-pound rail and the track ballasted with furnace slag. The bridges will carry 6,600 pounds to the lineal foot. The standard locomotive is the consolidation pattern, having cylinders 22 in. × 28 in. and weighing 170,000 pounds on the drivers alone. The ore equipment consists mostly of steel cars, weighing 17 tons and carrying 50 tons of ore. The company is having built a few of what will prove to be the heaviest locomotives in the world, having cylinders 23 in. × 32 in., and weighing 217,000 pounds on the drivers. With these locomotives the total weight of an ore train, including the locomotive and light weight of the cars, will be about 2,600 tons.

But it is not only in the operation of the road that greatest economy is obtained, but also in the transfer of the ore from the lake steamers to the trains. The steel company owns the entire harbor at Conneaut. Nine ships can be docked at the same time. Twenty-five thousand tons of all classes of freight can be handled every 10 hours. The most modern machinery is used for handling ore and coal. A 6,000-ton ship can be cleared in 14 hours, and in the same time from the moment the hatches are opened the ore can be at the furnaces at Pittsburgh. A new steam shovel was completed last winter by which a train of 35 to 40 cars will be loaded with ore in 2 hours. A 40-ton car of coal can be unloaded and partly trimmed in the ship in 36 seconds. Most of the switching at Conneaut is done by the haulage system (a cable running between the rails at about 4 miles per hour). The operating officers believe that with this railroad the utmost limit of all that is possible in solving the problem of cheap transportation has been reached. Their achievement shows what remains to be done, and can be done by the other railroads of this country in the same direction.

Rock Determination.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *appears* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 608 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

The Granitic Rocks.

Granite is such a familiar rock that we might think that every one would know it when they saw it and not be likely to mistake it for other rocks. But such is not quite the case. We have met prospectors and miners who mistook granite for other varieties of eruptive rock, and vice versa. One man, for instance, told us he "had granite for the roof of his tunnel and limestone for the floor;" in other words, the impossible condition of granite overlying limestone. On examination we found the so-called granite to be a peculiar granite-like intrusive porphyry sheet.

The great Elk Mt. diorite laccolites were for a long period said to be "eruptive granite," and no wonder, for the rock diorite is often at sight scarcely distinguishable from some granite; and so with many of the eruptives, miners either calling them granites, or trachytes, both terms being commonly incorrect.

As a rule, in Colorado at least, we may say that when bodies of igneous, crystalline rock are found overlying, or intruded up through sedimentary rocks, cutting across the beds or sending out sheets between the sedimentary strata, or overlying the strata, these are never granites, but some other form of eruptive rock. In Colorado, the granite *underlies* all sedimentary rocks, though by its erosion it may tower above them.

That granite should be confused with other eruptive rocks from its similarity in appearance to them is the more pardonable when we find how closely related granite is to many of these, both in structure, texture, and origin, and how many of these igneous rocks bearing different names may have been indirectly derived from the parent granite, by a natural passage or transition, in some cases perhaps by a local chill, in others by an excess of heat, or other fortuitous circumstances. In fact it would seem as if granite might be indeed the parent of almost all rocks, not merely the fragmental sedimentaries whose origin from it is obvious, but even the so-called igneous and volcanic rocks to which we give various names. There is none of these latter rocks but what carries in it some of the same elementary minerals as compose granite, and others which by transmutation might be referred back to them.

Composition.—Granite proper is made up of three principal minerals, viz., quartz, mica, and feldspar; when hornblende is added with the mica it is called hornblende granite. Granite with black mica, or biotite, in it is commoner than with white mica or muscovite. When biotite is alone present the rock is sometimes by ultrarefinement called "granitite." Large crystals of both micas very often occur in dikes or veins of coarse sparry granite, commonly known as pegmatitic veins.

The quartz in a piece of granite is generally easily distinguishable by its gray, crushed, transparent, broken glass-like appearance, showing no crystalline face or form. On the other hand, the feldspars are recognizable by their generally showing a portion of one flat face of their crystals glistening in the sun. Moreover, the feldspars are generally opaque, and commonly pink, red, or opaque gray or white. In a few cases they are white and transparent but even then can be distinguished from quartz by showing cleavage or crystalline faces. In the Front range of Colorado the feldspars are mostly a pale flesh color, producing a reddish granite; higher up in the range, the feldspars are often white and give a whitish or gray granite. The micas are easily recognized by their bright glitter and color; hornblende, when present, by its duller luster than mica, its greenish black tint, and its longer crystals.

Granite, as distinct from many of the porphyries and igneous lavas, has all its crystals crushed together in a general crystalline mass like lump sugar. You cannot extract from the rock any one

perfect crystal like a plum from a pudding, as you can out of some porphyries. There are occasions, however, where granite assumes a porphyritic habit with distinct feldspar crystals in a crystalline, finer-grained ground mass, as for instance, that forming the summit of Pikes Peak; such porphyritic granite is on its way to passing into a true porphyry.

The chemical analysis of a typical black mica granite as given by Kemp is: SiO_2 , 73.76; Al_2O_3 , 13.43; Fe_2O_3 , 1.16; CaO , 1.41; MgO , 0.75; K_2O , 5.22; Na_2O , 4.01; loss, 0.42; specific gravity, 2.63.

As silica decreases the bases increase. Soda tends to exceed potash, making the passage to diorites. Granites are made up of orthoclase feldspar with sometimes microcline and acid plagioclase feldspars, quartz, and micas; besides these, magnetite, apatite, zircon, and garnet are often present; these latter are generally very small or microscopic crystals.

When no dark silicates occur, but only quartz and feldspar, the rock is a "binary granite," or may be called a "pegmatitic granite," such for example, as the fine-grained deep red eruptive granite of part of Cripple Creek, composed of deep red orthoclase feldspar, and some quartz with little or no mica or hornblende. "Aplite" or pegmatitic veins is the name commonly given to the so-called miners' "quartz veins" in granite, which are generally an aggregate of rather large sparry crystals of feldspar and quartz with little or no mica.

Such veins are common in our cañons and form the matrix of many of our gold and silver ores. These veins might sometimes, in a sense, be called "dikes." Portions of these pegmatitic veins may be of that peculiar rock known as "graphic granite," formed of long blade-like intergrowths of crystals of quartz and feldspar, which when cut by a cross-fracture, suggest Hebraic characters. Garnet, tourmaline, beryl, epidote, and various other gem-like crystals are found in these veins of pegmatite. These veins, or dikes, may be 100 feet wide, or only tiny little lenses or ribbon-like wrinkles. Kemp considers that these larger veins or dikes could hardly have been produced by true igneous fusion to create such coarsely crystalline aggregates. "So we are forced to assume," he says, "such abundance of steam and other vapors, as to almost, if not quite, imply solution."

Just as porphyritic granites may pass into true porphyries, so the distinct crystals of granite porphyries may fail, and the ground masses becomes finer and finer, passing through a stage called microgranite into the felsites. The outer portions of granite masses are often subjected to the action of escaping vapors containing boracic and hydrofluoric acid (fumarole action); these develop into tourmaline, fluorite, and sometimes tin.

The colors of granite depend upon that of its constituent minerals, and the abundance or not of one kind of mineral. Thus, red granites are due to their red feldspar; white granites to a preponderance of white feldspars, and gray or dark gray granites to an abundance of mica or hornblende. Granites pass through granite porphyries and microgranites into quartz porphyries and felsites; along the borders of an intrusion this change can be traced inch by inch to a place where the porphyritic texture is due to a quick chill; granitoid rhyolites, or nevadites are closely related to granite.

As quartz decreases syenites or quartzless granites may result by insensible gradation, and as hornblende or biotite and plagioclase feldspar increase the same passage is to diorites. Intermediate varieties are granite diorites. Granite, also, by increase of augite and plagioclase passes into "gabbro." So we see how closely related granite is to other granite-like rocks called by very different names. Granites in great irregular masses that have solidified at depths and before consolidating have fused their way upward by melting into themselves overlying rock are called "bathylites." Granites appear as irregular rounded outcrops in the midst of other rocks, as bosses, knobs, and dikes. There is no reason why granites should not form at all geological ages, but those open to our observation are mostly of Archean and Paleozoic age, because being deep-seated rocks, only the older ones have been exposed by erosion.

Granites break apart by jointing planes in rectangular blocks and often look like portions of Cyclopean walls of masonry.

These are sometimes eroded away until only a single tower is left standing on the granite plain. Of such are the Cheese Rings in Cornwall comparable to a pile of cheeses lain one on top of the other. These were doubtless used by the Druids for sacrificial altars, the blood of the sacrifices being, at times, poured into circular holes worn out by rain erosion into natural chaldrons.

It is not uncommon in parts of the mountains to see fragments of Algonkian schists that once overlay the granite partially fused and incorporated into the granite itself. Granites are among the strongest of building stones, the crushing resistance ranging from 10,000 to 25,000 pounds per square inch in a 2-inch cube. The important points in a building-stone granite are homogeneity of texture, good rectangular cleavage in the quarry, adaptability to tool treatment, and pleasing color.

Decay of Granites.—In decay, granites suffer first by oxidation of protoxide of iron in the iron manganese silicates, biotite mica, and hornblende, and the formation of a greenish substance called chlorite. The feldspars kaolinize, or turn to china clay. In Cornwall, near St. Austel, in the hills above the town is a whitish granite containing a large proportion of white feldspar. Springs issuing from these granites have decomposed their lower portions, producing extensive beds of fine white kaolin, china, or pipe clay. This is run down into vats where the quartz and mica separate by settling, leaving a residuum of pure white clay. The streams that originate in these beds now appear to run in milk since the works were opened. Most of our kaolin, or porcelain clay used for making white chinaware is derived from the feldspars of granitic or igneous rocks.

As regards the oxidation and decay of the blacker constituents, mica or hornblende, you will often notice a dull gray "pitted" look on the face of some granites. This results from the decay or oxidation of mica. It is often difficult at sight to determine whether these tarnished greenish-gray spots are mica or hornblende, but by inserting the point of a penknife in such dark spots, scale will come off and reveal a bright sparkling mica face below. Hornblende will not so scale off and will not show so bright a face.

We used to suppose popularly that gneisses were stratified granites laid down in beds, perhaps, by heated waters like sedimentary rocks, and such some of the late Algonkian gneisses may have been, but it is certain that many of these schists and gneissic structures have been produced by mechanical strain and shearing. Granites abound in the mountains of the United States and usually constitute the core of the ranges.

MINE TIMBERING.

Various Methods of Cutting and Placing Timbers to Secure the Best Results.

By David J. Evans, Ehrmannndale, Ind.*

All subjects pertaining to mining should be interesting to us, and not the least among them is timbering. I will try to give this institute my experience in timbering a mine, and hope that some of the members, at least, will appreciate my effort in describing this branch of practical mining.

I will not say anything in this paper about putting up props, although there are many miners who cannot, or at least do not, put them up in a way that is safe and substantial, but will confine the paper to the cross-bars, the various ways of notching, fitting, and supporting them.

The best way, I believe, to put up a cross-bar is to make a hitch in, or on top of the coal for its support whenever that is practicable; provided, however, that all loose coal, or coal that is leaning out over its bottom be taken down or cut away before making said hitches. I have seen bars put up so carelessly or in such a hurry to finish the job that the hitches have been made on top of overhanging coal that was barely able to support the weight of the bar, without considering any weight that might come on the bar from the roof. In a case like this the place has been made more dangerous instead of having been made safe. Some of you, no doubt, have seen bars that have been put up thus falling with very little besides their own weight. Such bars are nothing but traps, and a mine boss should not tolerate such timbering under any circumstances whatever.

If the coal is not high enough to get the bar to the roof, or as high as necessary, put in a block of wood on the coal, under the bar, to make it high enough. It is not good policy to make

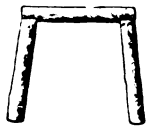


FIG. 1.



FIG. 2.



FIG. 3.

hitches in slate, for it will often crumble with the air and may let the bar down. Put a bar up right and it is there to stay, and will give you no more trouble until it decays or is broken by weight.

There are cases, however, where the bars are too short, or the coal not solid enough to risk a bar on it, and some men will put straight props under them for support. This idea of timbering is faulty, for the reason that if the bottom is soft and any extra weight comes on the bar the prop will give way in the bottom, and not only will it sink in the bottom but will also work

towards the track where the cars by passing will strike it and make the place very dangerous, especially for the drivers.

The best way to support a bar that is not resting on the coal is with the leaning leg. Here we come to another phase in timbering. Here there is a right and a wrong way of notching. In this case it is in the leg or support where the difference is. I believe everybody that knows anything about timbering, and uses notched timber, notches the bar very nearly alike.

The fault in notching the leg is that the front or face of the leg is cut too straight up (Fig. 1). Consequently it does not

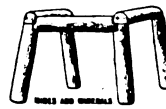


FIG. 4.



FIG. 5.



FIG. 6.

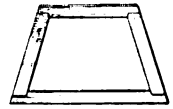


FIG. 7. •

support the bar under the notch and it gives the bar a chance, with any extra weight to split. With this kind of notching of the leg, a big per centage of the strength of the bar is lost.

Here (Fig. 3) is a better way of notching. By throwing the face of the leg well back, the bar, when weight comes on it, buries itself in the face of the leg and is therefore prevented from splitting and will support all the weight that the wood in the bar is able to support, and if the weight is excessive, the bar may bend or break but will not split.

All other timbering is only the bar and leg put in different positions, combined with other bars and legs. I will here try to describe some of those combinations.

Having to deal with bad roof over switches has caused a combination in timber. Here again the bars on the coal can be put up, provided the place is suitable for them. Put one bar across the mouth of the room, the heads resting on each corner of the room, and put two more, one from each corner across the entry in very nearly a triangular shape, which, if the roof is not very bad, the bars good and strong and put up substantially, will often make the place safe.

But if the place does not suit that way of timbering and we can spare the height from the room or the place that is turning off, then we can put up a bar with both ends on the coal, or with one end on the coal and the other notched and resting on a leg; or, as I have known cases where legs have to be put under each end of a big bar and put two or more bars to rest on it with legs under them on the other side of the entry (Fig. 6). If bars are put up in this way, then care should be taken to have all the legs to lean towards one another, so that weight on one side cannot push them out of position.

Another way to timber a switch is to get two corner legs, rather large, face them on two sides—at right angles—put a bar across the room on them, also one on each of them across the entry, similar to the three bars on coal; but in this case they have to be put at right angles instead of in a triangle. The off end of the bars across the entry can be put on the coal if care is taken to wedge solid and have them of proper length so that the legs will be leaning in a little towards the main road (Fig. 5). If a bar is needed in the middle it will be its thickness above the other bars. This is a good way when you want the same height on both roads, the roof being "heavy," but not very badly broken; or where it does not require close timbering or lagging.

There is yet another way to frame a switch. The two main legs in this case also have to be rather large, the same as in the last case. Notch them on top, but at the angle that the leg leans sideways and put another notch in the side, the same as in a bar, but somewhat deeper, about the thickness of the bar, or less, below the top, then notch the bar across the room to fit in these hitches and one on each leg across the entry. I have used this kind of timbering where I had to take advantage of every inch in height. With very little work, sometimes, you may get a bar across the middle of the switch with this notch, where it would cause lots of labor with the other, or you would have to let your big bar too low (Fig. 4). If you have a place with good roof, but with side pressure, this is the best way that I know of to support it. Spread the legs as wide as possible in the bottom, let the legs lean over about 1 in 6, or may be 1 in 5 would be better, but it is not good policy to have them lean over more than that; put the bar down as low as possible without taking too much of the height, make a notch in the bar to fit the front of the leg to keep it from splitting, wedge all tight on top, and it will take a pretty good pressure to dislodge them.

You all know about timbering a double track. It is the same as timbering a single track, except that the timbers are heavier. But sometimes we have to put support in the center of these long bars. It is not desirable to have props in the center, but sometimes it cannot be avoided. When we put up bars with a center support, I think the best way is to put up good stout props in the

* Read before the Indiana Mining Institute.

center first (Fig. 2), in which two hitches have been made on opposite sides, the height you want the bars from the bottom, then wedge the post upright to the roof, facing in both tracks. Now, by cutting hitches on both sides, or by notching or putting up legs, you can get your bar up in two pieces, which will be easier handled than by putting up a big bar and then putting a post in the center. If, in this way, one part of the bar breaks, you can change it without taking the other part down at all.

There is a way, however, that the center of a bar can be supported without post if you have enough height. Put short posts in the sides, say about half the height of the bar, and set braces from them to about one-third of the bar and put a cleet in between them, and we have very near an arch of wood.

The reason that I favor the leaning leg in timbering is, that often you can set a leg on coal, which is far better than on the bottom. If putting the leg on the bottom cannot be avoided, it has a tendency to push in under the coal, which is the hardest part of the bottom, hence is more able to support the weight of the roof.

The way that is generally in use in timbering the mouths of slopes and drifts differs a little in the cut of the leg (Fig. 7). This is what I would call a double notch. The bar is notched the same in this case as other bars are, but instead of making a smooth face for the leg, a step is made in it the same distance from the top that the depth of notch is in the bar and they are fitted together. I do not think this way is any better than the other way, but others timber in this way and we want to know how. If a sill is to be put under these timbers, cut it down where you want the front of the leg and feather edge it toward the back according to the pitch of the leg and you have a good foundation. The sill ought to reach across under both legs. I think it unnecessary to mortice and tenon these timbers. These are supposed to be sawed timbers.

Timber for a timber man should come to the mine without being hewed. I like to face my own timber, for by doing so I can always put the crook in the bar up where it ought to be.

To notch timber I prefer a hatchet made by the mine blacksmith to one of those ready made from the store. It is made like a roadman's hatchet, weight about 4 pounds, with handle about 15 inches long. It is about the handiest tool I have ever used in this kind of work if made right and of good material. With this hatchet I like a good saw—seven teeth to the inch I think about right—a pair of forks made of $\frac{3}{8}$ -inch iron, a pick and shovel, and a measuring stick. I make this in two parts of two pieces of pine, 1 in. $\times$ 3 in., and tack a piece of tin or sheet iron on one end of each just the size for the other to slip through easily. It is one of the handy tools. Getting a blacksmith to put a strap of iron on one end with a thumbscrew in it would be still better. Put any marks on it to suit yourself.

The Mineral Industry in the Ural Mountains.

Of all the known mineral districts, probably none resembles our own Rocky Mountain district in the richness and variety of its resources as much as does the mineral-bearing section of the Ural Mountains. In view of the increased trade with Russia, and the fact that several American works have Russian branches, the following description of the Ural Mountains, by A. H. d'Escailles, in the *London Mining Journal*, will be of interest:

The development of the mineral and metallurgical industry in the Urals has been much discussed in Russia of late, and already a plan for the organization of an industrial bank has been drawn up, with the object of supplying credit to the mines and factories in order to facilitate the transformation of their material and the development of their explorations. The necessity of extending the railway network for the improvement of the present very unfavorable conditions of transport has also been acknowledged. Let us consider now the mineral organization. We shall, if we consult the great chart, in 12 sheets, edited by the Mines Department, showing the division of the territories in the Ural region, see indicated: (1) The domain formed by the works of the State or of "The Crown;" (2) Those of the manufactories situated on land belonging to the State, but conceded to private industrials; (3) Those of the private works; (4) The territories belong to the Cossacks and Bachkirs.

We will give a resume of the state of the industry in the most important districts of the Ural. The kinds of fuel utilized by the mineral industry are various: coal, coke, turf, wood, charcoal, and naphtha. Although Carboniferous soil exists on the western side of the mountains, and in many places coal has been found, it is only exploited in a rather limited region, and its quality is but mediocre. On the eastern side, also, coal is met with on certain spots, which were worked in olden times. Turf covers large areas, especially on the auriferous placers, where it is often utilized as fuel, and in the Verkisert district it serves to make small briquettes. Wood is extensively employed by puddlers, but

it is chiefly after carbonization, charcoal playing a preponderant role throughout the Urals. The residuum from distillation of naphtha is used in many factories, especially in the southern part of the range, and the application of naphtha to the Martin furnaces, made some time ago at the metallurgical works of Moscow, is of particular interest for the Ural region. The iron ores of the Urals are: The magnetite (in the Magnitkaia and Visokaia mountains and the Blagodat Mount); the brown hematite, met with in the south and in the middle zone, especially at Bakal; the ologishoron, which is found in the north; and the red hematite and the siderose (iron wood) which exists in the west. The exploitation of these beds is performed in a very primitive manner, which is certainly capable of vast improvement. The blast furnaces are heated by charcoal; they are generally of a medium size, and produce about 20 tons in 24 hours. The old types are still numerous, but there are, also, as at Tchussovaia, furnaces of modern construction. The blast furnaces are usually in buildings entirely closed and covered by cupolas of quite a special character. For a long time, pig iron was the sole production of the Urals, but for some few years now the fabrication of steel has steadily developed. A great number of the iron works are still carried on according to the old system, especially those that turn out thin sheet iron, which is much in demand for roofs in Russia. The puddling furnaces are also very numerous, and are generally heated by charcoal or naphtha. Steel is almost wholly manufactured by means of the Martin's furnaces and in a great number of the workshops new ones are actually in course of construction. The number of Bessemers existing in the district is only four, two of which are in one of the numerous manufactories of Nijni-Tagilek, belonging to the heirs of Demidoff, Prince of San Donato, whose ancestors founded the iron industry in the Urals. These establishments have preserved a great repute for several centuries.

The Russian production of copper was for many years restricted to the Ural region, but it has recently undergone great development in the Caucasus, for if Altai and Finland do not seriously count, the steppes of Khirghizes, if worked with modern machinery, seem capable of producing an important quantity. The copper beds of the Ural range are of two kinds. (1) Primitive beds situated on the eastern side, especially at Mednorondiansk, where the chalcopryite and magnetite are found. (2) Reworked beds on the western side, which exist in different varieties of rock, and particularly in the grit belonging to the Permian system. The ores, which are oxidized, have only a basis of 2 or 3 per cent. Mines of this nature, situated in the neighborhood of Orenbourg, towards the south of the Urals, produce also a small quantity of metal, the quality of which is much appreciated. At the present time, the two chief centers of copper production are to the northeastward of Bogosloff, where the treatment by the converter is practiced, and at Nijni-Tagilek, where oxidized and pyritic ores are treated in the following manner: Fusion of matte, roasting, reducing, fusion and affinage.

An important innovation has been practiced in the Ural region during the past few years, and which will, doubtless, add greatly to the output of metals, namely, the employment of coal. As regards gold, it is only quite recently that attention has been given to the wealth contained in the veins. The method of working is largely by piecework, and the men are called "starelli." They have transmitted their deftness of hand and their special but primitive methods of washing the ore from generation to generation. Altogether 85,000 people are employed in the working of gold and platinum, 13,500 in naphtha, 15,000 in salt mines, and 36,000 at the blast furnaces, in manufactories, and divers other occupations connected with the mineral exploitation. In the great works there are apparatus fitted with disintegrating mills for the washing. They treat the gold obtained from the veins in the usual manner. The crushing and the enriching of the ores and amalgamation is performed by grinding mills and on amalgamated copper plates. The chemical processes for the treatment of complex ores have been recently installed—chlorination by the Plattner and the Munktel processes and cyanide process by the MacArthur-Forrest method. Platinum is met with on the Asiatic side of the mountains in the basin of the Martian River, and further towards the north in the basin of the Isse River. These places are, excepting a few spots in Colombia, which produce very little, the only regions in the world where a supply of platinum is obtained. The platinum market, however, is almost completely controlled by England. The first native bed of platinum was discovered in the Urals in 1892 in a serpentine rock. The working of platinum mines very much resembles that of gold mines, but it is even more simple, since it does not include amalgamation. The museum of the Institute of Mines, at St. Petersburg, possesses large nuggets of platinum, and other rare samples are also exhibited there, such as gold nuggets, blocks of malachite, crystals of topaz and beryl of extraordinary size; and among other different specimens from the Urals are superb emeralds and diamonds.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Many of the questions given by the several State Boards of Examiners suggest principles which can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question, which should be as brief and concise as possible. It is the purpose of MINES AND MINERALS, to discuss in this department of "Examination Questions" the principles of practical mining upon which these questions are based, feeling sure that such articles will be appreciated by and be a help to all who are preparing themselves for mine examinations.

Mine Inspectors' Examination, Held at Des Moines, Iowa, March 5, 6, and 7, 1900.

QUES. 1.—What is meant by "motive column," and what will be its numerical value in a case where the depth of downcast is 300 feet, temperature of downcast 32° F., and temperature of upcast 48° F.

ANS.—The term "motive column" is fully explained in reply to Ques. 2, page 426, MINES AND MINERALS, April, 1900. There are two formulas, however, for motive column, the one giving the value of the motive column in terms of the downcast air, and the other giving its value in terms of the upcast air. The height of these motive columns will be different since they are composed of air of different density, the former being the shorter of the two columns since it is composed of denser air. These two formulas are given and their application explained in the answer to Prize Contest Question 546, page 316, MINES AND MINERALS, February, 1900.

Applying these formulas to the example given above we have, for the motive column in terms of the downcast air at a temperature of 32° F.,

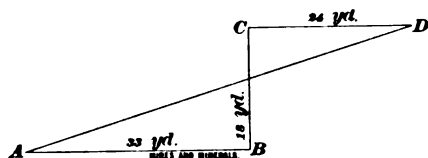
$$M = 300 \times \frac{48 - 32}{459 + 48} = 300 \times \frac{16}{507} = 9.467 \text{ ft.}$$

Again, for the motive column in terms of the upcast air, we have $M = 300 \times \frac{48 - 32}{459 + 32} = 300 \times \frac{16}{491} = 9.776 \text{ ft.}$

QUES. 2.—An airway is 7 ft. $\times$ 10 ft. in section, and 5,000 feet in length. Taking the coefficient of friction as .00000001, what pressure will be required to pass 60,000 cubic feet of air through this airway per minute?

ANS.—Applying the formula for pressure $p = \frac{k l o q^2}{a^3}$, we have, in this case,
 $p = \frac{.00000001 \times 5,000 \times 2(7 + 10) \times 60,000^2}{(7 \times 10)^3} = 17.843 \text{ lb. per sq. ft.}$

QUES. 3.—A point which may be known as B is 33 yards east of another known as A. C is 18 yards north of B, and D is 24 yards east from C. What is the distance from A to D?



ANS.— $AD = \sqrt{18^2 + (24 + 33)^2} = 59.77 \text{ yd.}$

QUES. 4.—If 40,000 cubic feet of air pass each minute through an airway 6 ft. $\times$ 8 ft. in section, while the water gauge is 1.2 inches, what quantity will pass per minute through another airway of the same length, 8 ft. $\times$ 12 ft. in section, when the power producing the ventilation is the same?

ANS.—When the power remains the same, the quantity of air in circulation varies as the expression $\frac{a}{l^3 o}$, in which a = area of airway (sq. ft.); l = length of airway (ft.); o = perimeter of airway (ft.). In the present case, the length of the airways being the same, the quantity varies as the expression $\frac{a}{l^3 o}$, and we write the proportion,

$$\frac{(6 \times 8)}{l^3 2(6 + 8)} : \frac{(8 \times 12)}{l^3 2(8 + 12)} :: 40,000 : x,$$

$$\text{or } x = 40,000 \times \frac{8 \times 12}{6 \times 8} \times \frac{2(6 + 8)}{2(8 + 12)}$$

Canceling the common factors and simplifying, we have

$$x = 40,000 \times 2 \times \frac{7}{10} = 80,000 \times .8879 = 71,032 \text{ cu. ft.}$$

QUES. 5.—The area of the piston of an engine is 500 square

inches; the mean effective pressure per square inch is 30 pounds; length of stroke 8 feet; and number of strokes per minute 20. What is the horsepower of the engine?

ANS.—The theoretical horsepower of the engine is calculated by the formula

$$H = \frac{p \times l \times a \times n}{33,000},$$

in which

p = pressure (lb. per sq. in.);
 l = length of stroke (ft.);
 a = area of piston (sq. in.);
 n = number of strokes per minute.

Substituting numerical values for these letters, we have

$$H = \frac{30 \times 8 \times 500 \times 20}{33,000} = 72.7 \text{ H. P.}$$

QUES. 6.—A fan making 50 revolutions per minute gives 4½ pounds pressure per square foot. If the speed be increased to 75 revolutions per minute, what will be the reading of the water gauge?

ANS.—It is customary to estimate the yield of a fan as being proportional to its speed. Pressure in any circulation varies as the square of the quantity. Hence, it follows that the pressure will vary as the square of the speed of the fan, or

$$50^2 : 75^2 :: \frac{4.5}{5.2} : x, \text{ or } x = \frac{4.5}{5.2} \times \left(\frac{75}{50}\right)^2 = 1.947 \text{ in. w. g.}$$

As a fact, however, the quantity of air does not vary exactly as the speed, but more accurately as the fifth root of the fourth power of the speed. That is to say, if we double the speed, we do not obtain double the quantity, but about 1.74 times the quantity. It follows from this that the pressure does not vary exactly as the square of the speed, but more accurately as the fifth root of the eighth power of the speed. That is to say, if we double the speed, we do not obtain $2^2 = 4$ times the pressure, but we obtain $2^{\frac{8}{5}} = 3.03$ times the pressure. These latter figures correspond more accurately with the results of practice, but the former is the customary method of calculation.

QUES. 7.—What horsepower engine is required to ventilate a mine working 300 men, when the water gauge stands at 1 inch?

ANS.—Assuming that 300 miners will require say 6 mules, and since the mining laws of Iowa require 100 cubic feet of air per minute per man, and 500 feet per minute per mule, we have for the required circulation in this mine $300 \times 100 + 6 \times 500 = 33,000$ cubic feet of air per minute. If the water gauge is 1 inch, the horsepower of the engine required for this ventilation, assuming an efficiency of 60 per cent. for the engine is calculated as follows:

$$\text{w. g.} = \frac{33,000 \times 1 \times 5.2}{.60 \times 33,000} = 8.66 \text{ H. P.}$$

QUES. 8.—If the modulus of the machinery producing ventilation be 62, what horsepower must be performed in maintaining a volume of 120,000 cubic feet of air per minute, with a water gauge of 1.39 inches?

ANS.—Assuming that by "modulus" is meant the efficiency of the ventilating machinery, this being 62 per cent., the horsepower concerned in this circulation is calculated as follows:

$$\frac{120,000 \times 1.39 \times 5.2}{.62 \times 33,000} = 42.4 \text{ H. P.}$$

QUES. 9.—If 50,000 cubic feet of air pass per minute through an entry having a sectional area of 20 square feet, and a rubbing surface of 20,000 square feet, what is the reading of the water gauge?

ANS.—The water gauge in this example is calculated as follows:

$$\text{w. g.} = \frac{.0000000217 \times 20,000 \times 50,000^2}{20^3 \times 5.2} = 26.08 \text{ in.}$$

QUES. 10.—If by the application of 42,000 units of work, a current of 31,500 cubic feet of air is set in motion, in a mine, how many units of work are required to circulate 70,000 cubic feet of air in the same mine?

ANS.—Since in any circulation the power or work producing the current varies as the cube of the quantity of air in circulation, we have $31,500^3 : 70,000^3 :: 42,000 : x$, or $x = 42,000 \times \left(\frac{70,000}{31,500}\right)^3$

$= 42,000 \left(\frac{20}{9}\right)^3 = 42,000 \times 10.974 = 460,908$ units of work.

QUES. 11.—With a fan 8 feet in diameter, making 250 revolutions and passing 62,000 cubic feet of air per minute, when the water gauge stands at 1 inch, what is the equivalent orifice?

ANS.—The equivalent orifice of this circulation is calculated as follows:

$$a = \frac{.00038 \times 62,000}{1} = 23.56 \text{ sq. ft.}$$

QUES. 12.—100,000 cubic feet of air pass through an airway 6 ft. $\times$ 5 ft. sectional area, and 10,000 feet long. This is divided into three splits, one of which is 6 ft. $\times$ 6 ft. in section, 2,000 feet long; another 6 ft. $\times$ 5 ft. in section, and 4,000 feet long; and the

third 6 ft. $\times$ 4 ft. in section, 6,000 feet long. What quantity of air will pass each split while the pressure remains the same?

Ans.—The main airway 6 ft. $\times$ 5 ft., 10,000 feet long, may be ignored in this calculation, assuming only that the three splits mentioned start from the same point, at the end of this main airway, and that the pressure is the same at the mouth of each of these splits. The quantity passing in each split will then be

proportional to the expression $a\sqrt{\frac{a}{l}}$, and we find as follows:

$$\begin{array}{l} \text{Split A, } a\sqrt{\frac{a}{l}} = 36\sqrt{\frac{36}{48,000}} = .9859 \\ \text{Split B, } a\sqrt{\frac{a}{l}} = 30\sqrt{\frac{30}{88,000}} = .5539 \\ \text{Split C, } a\sqrt{\frac{a}{l}} = 24\sqrt{\frac{24}{120,000}} = .3394 \\ \text{Total, } 1.8792 \\ \text{Split A} = \frac{.9859}{1.8792} \times 100,000 = 52,463 \text{ cu. ft.} \\ \text{Split B} = \frac{.5539}{1.8792} \times 100,000 = 29,475 \text{ cu. ft.} \\ \text{Split C} = \frac{.3394}{1.8792} \times 100,000 = 18,062 \text{ cu. ft.} \\ \text{Total, } 100,000 \text{ cu. ft.} \end{array}$$

QUES. 13.—In what time can an engine of 40 effective horsepower pump 4,000 cubic feet of water from a depth of 360 feet?

Ans.— $4,000 \times 62.5 \times 360 = 90,000,000$ foot-pounds, total work. Each horsepower equals 33,000 foot-pounds per minute, then, since 40 horsepower is effective for the performance of this work, we have for the required time, $\frac{90,000,000}{40 \times 33,000} = 68.18$ minutes.

QUES. 14.—In a certain entry the velocity of the ventilating current is 10 feet per second. What will be the velocity of the air current in another entry of double the length, if the area and the water gauge are the same as in the first entry?

Ans.—In any given airway, when the pressure remains constant, the velocity varies as $\sqrt{\frac{a}{l}}$, in which a = area, l = the length, and o = the perimeter of the airway. In this example, however, the area and, presumably, the perimeter are the same in each entry; and the lengths of the entries are to each other as 1 : 2. Hence, we have

$$\sqrt{2} : \sqrt{1} :: 10 : x, \text{ or } x = \frac{10}{\sqrt{2}} = 7.07 \text{ ft. per sec.}$$

QUES. 15.—If the indicated horsepower of an engine operating a fan is 40, while the horsepower of the air is only 28, what is the percentage of useful effect of the engine?

Ans.—The percentage of useful effect of this engine is calculated as follows:

$$\frac{28}{40} \times 100 = 70\%.$$

This is the mechanical efficiency of the engine and ventilator combined.

QUES. 16.—With a fan of 30 horsepower, from which you are obtaining only 50 per cent. useful effect while the water gauge stands at 2.3 inches, what quantity of air per minute should you get?

Ans.—Since there is 50 per cent. of useful effect in this case, the horsepower effective upon the air is $30 \times .50 = 15$ horsepower. The quantity of air passing with this power and a water gauge of 2.3 inches, is calculated as follows:

$$q = \frac{15 \times 33,000}{2.3 \times 5.2} = 41,388 \text{ cu. ft. per min.}$$

QUES. 17.—A furnace is capable of producing 42,670 cubic feet of air when operated alone, but when combined with a fan, the two produce 46,706 cubic feet per minute. What will the fan produce by itself?

Ans.—Since the furnace and the fan will each perform the same amount of work whether running together or singly; and since the work is always proportional to the cube of the quantity in any given airway, we have

$$q_1 = \sqrt[3]{Q^3 - q^3} = \sqrt[3]{46,706^3 - 42,670^3} = 28,923 \text{ cu. ft. per min.}$$

QUES. 18.—If 40,000 cubic feet of air per minute pass through an airway 6 ft. $\times$ 6 ft. sectional area, with a water gauge of 1.4 inches, what amount of air will pass through another airway of the same length, 8 ft. $\times$ 8 ft. in section, when the pressure is the same?

Ans.—The pressure remaining the same, the quantity of air

in circulation varies as the expression $a\sqrt{\frac{a}{l}}$. Since the airways have the same length, in this example, we have

$$36\sqrt{\frac{36}{24}} : 64\sqrt{\frac{64}{32}} :: 40,000 : x,$$

and

$$x = 40,000 \times \frac{16\sqrt{\frac{2 \times 2}{9}}}{3} = 82,112 \text{ cu. ft. per min.}$$

Since these airways are similar airways, the pressure remaining the same, we may apply the law that the quantity of air in circulation will vary as the square root of the fifth power of the similar sides, thus

$$\sqrt[5]{6^5} : \sqrt[5]{8^5} :: 40,000 : x,$$

$$\text{or } x = 40,000 \times \sqrt[5]{\left(\frac{8}{6}\right)^5} = 82,112 \text{ cu. ft. per min.}$$

QUES. 19.—How much work is done in raising 300 tons of coal up an incline 2,700 feet long, and rising 1 foot in 3, when the friction of the cars adds 40 per cent. to the load?

Ans.—It will be necessary, in answering this question, to assume the number of trips hauled or the load hoisted in each trip. Assuming this work is done in making 25 trips, we have $\frac{300}{25} = 12$ tons per trip. This is the weight of the coal hoisted in each trip, and to this must be added the weight of the mine cars, which we may assume to be one-third of the weight of the coal hoisted or $\frac{12}{3} = 4$ tons per trip. Then the weight of the loaded trip equals $12 + 4 = 16$ tons. The next step is to determine the size of the rope required for this hoist, inasmuch as the gravity pull of the rope and its friction upon the incline must be added to the gravity pull of the loaded trip, in order to obtain the total load upon the rope. We find the tension upon the rope due to the gravity pull and the friction pull of the loaded trip and the rope as follows:

$$T = (W + wl) \times \left(\sin a + \frac{\cos a}{40} \right),$$

in which W = the weight of the loaded trip;
 w = the weight of the rope per lineal foot;
 l = the length of the incline;
 a = the angle of the slope, or the inclination of the plane.

It will be observed that the gravity pull is always obtained by multiplying the load by the sine of the slope angle; while the friction pull is found by multiplying the load by $\frac{1}{40}$ th of the cosine of the slope angle since the friction is $\frac{1}{40}$ th of the normal pressure of the load upon the plane. In this case, the incline rises 1 foot in vertical height, for each 3 feet of horizontal distance, the tangent of the slope angle being $\frac{1}{3} = .3333$. We have, therefore, for the slope angle in this case, $a = 18^\circ 26'$; and $\sin a = .3162$, $\frac{\cos a}{40} = .0237$. Assuming a weight of rope equal to

1.58 pounds per foot, and substituting the given values, we have $T = (16 \times 2,000 + 1.58 \times 2,700) \times (.3162 + .0237) = 36,266 \times .3399 = 12,327$ pounds; or, say 6 tons. Using a plow-steel wire rope, having six strands of seven wires each, we find the breaking strain of a 1-inch rope, weighing 1.58 pounds per foot, to be 42 tons, which will give, if we use this rope, a factor of safety of about 7. If we multiply the tension, or pull upon the rope, by the distance through which this pull is exerted in hoisting the 300 tons of coal up this incline, we will obtain the total work performed in hoisting this amount of coal. Thus, calling the total work U , we have $U = 12,327 \times 2,700 \times 25 = 832,072,500$ foot-pounds.

QUES. 20.—If 10,000 cubic feet of air pass each minute into a mine having two splits, one of which is 4 ft. $\times$ 12 ft. in section and 6,000 feet long, and the other 6 ft. $\times$ 8 ft. in section and 10,000 feet long, how will the current be divided?

Ans.—This example is solved in the same manner as Ques. 12 above. We first calculate the value of the expression

$a\sqrt{\frac{a}{l}}$, for each split as follows:

$$\text{Split A} = 48\sqrt{\frac{48}{2(4+12)6,000}}$$

$$\text{Split B} = 48\sqrt{\frac{48}{2(6+8)10,000}}$$

Since these values for each split are merely used as ratios the work may be much simplified by first canceling all factors

common to each split. Doing this we obtain the following values:

$$\text{For split A, } \frac{1}{\sqrt{8 \times 3}} = .204$$

$$\text{For split B, } \frac{1}{\sqrt{7 \times 5}} = .169$$

$$\text{Total, } .373.$$

The quantity of air passing in each split is then,

$$\text{Split A, } \frac{.204}{.373} \times 10,000 = 5,469 \text{ cu. ft. per min.}$$

$$\text{Split B, } \frac{.169}{.373} \times 10,000 = 4,531 \text{ cu. ft. per min.}$$

$$\text{Total, } 10,000 \text{ cu. ft. per min.}$$

Ques. 21.—If 33½ per cent. be allowed for friction, what weight can be lifted by a pair of first-motion engines, having cylinders 16 in. × 32 in. and a drum 8 feet in diameter, when the steam pressure is 60 pounds per square inch?

Ans.—Having a cylinder pressure of 60 pounds per square inch and the diameter of the cylinder being 16 inches, the total cylinder pressure is $.7854 \times 16^2 \times 60 = 12,064$ pounds. Since the length of the stroke is 32 inches, the crank arm upon the drum shaft is $\frac{32}{2} = 16$ inches, and the moment of the cylinder pressure at the center of the drum shaft will be $12,064 \times 16$. Since the diameter of the drum is $8 \times 12 = 96$ inches, the moment of the load (W), upon the winding rope, will be $W \times \frac{96}{2} = 48 W$. These two moments must be equal to each other, and we have for the total load (W), including friction, $W = 12,064 \times \frac{16}{48} = 4,021$ pounds. Since 33½ per cent. of this load is absorbed by the friction of the hoist we have for the net load hoisted $4,021 \times \frac{2}{3} = \text{say } 2,680$ pounds.

Ques. 22.—9,000 cubic feet of air per minute pass through a regulator, at which the difference of pressure of the two sides is equal to $\frac{1}{16}$ of an inch of water gauge. How far is the regulator shutter open, if it is 1 foot in depth?

Ans.—The usual method of estimating the size of opening in a box regulator, when the difference of pressure between the two sides of the regulator is given in inches of water gauge, is by using the formula,

$$a = .00038 \frac{Q}{\sqrt{i}}$$

in which a = the area (sq. ft.) of the opening;
 Q = quantity of air passing (cu. ft. per min.);
 i = water gauge (in.).

Substituting the given values in this equation, we have for the area of the opening

$$a = .00038 \frac{9,000}{\sqrt{.7}} = 4.088 \text{ sq. ft.}$$

If the height of the opening is 1 foot, then the width of the opening will be $\frac{4.088}{1}$, or 4.088 feet.

Ques. 23.—The entry of a mine is 7 ft. × 10 ft. in section and 6,720 feet long. What is the velocity of the ventilating current passing through this entry, when the water gauge stands at 2 inches?

Ans.—The velocity in this case is calculated from the formula $v = \sqrt{\frac{p a}{k s}}$, or since here $p = 5.2 \times 2 = 10.4$ pounds, we have for the required velocity in this case,

$$v = \sqrt{\frac{10.4 \times 70}{.0000000217 \times 2(7 + 10)6,720}} = 383.2 \text{ ft. per min.}$$

Ques. 24.—What should be the quantity of air for a mine producing 300 tons of coal per day? What should be the effective horsepower of the ventilator required to furnish it, when the water gauge stands at 1 inch?

Ans.—The average output of coal per miner per day is, say 2.5 tons in Iowa; then $\frac{300}{2.5} = 120$ miners required to produce this quantity of coal per day. To this number must be added, say 120 helpers or loaders, and 10 company hands, including drivers, timbermen, trackmen, trappers, and cagers. There will also be required, say 3 mules in this mine. The quantity of air required by law for the ventilation of such a mine would be $100 \times (240 + 10) + 500 \times 3 = 26,500$ cubic feet as a minimum quantity. We should estimate, however, upon a circulation of 28,000 or 30,000 cubic feet of air per minute. The effective horsepower for this circulation is calculated as follows:

$$\frac{30,000 \times 1 \times 5.2}{33,000} = 4.7 \text{ H. P.}$$

Changes Steel May Undergo in Tempering.

Many rules are laid down for the tempering of tool steel, and these do not in all cases agree. There are, in fact, many different methods employed by different blacksmiths, and numerous modifications of these methods are also in use, both in the tempering of drill steel and pick steel. In very few cases will two blacksmiths agree throughout in their ideas of the heating and tempering of steel. Each has an experience of his own, and each may be equally successful in the tempering and handling of the material of his work. It may be said that no hard and fast rule can be laid down for the edification of the unlearned. The tempering of steel is an art that must be acquired by experience, directed by a thorough technical knowledge both of the material in hand, and of the changes which it is liable to undergo in the several operations to which it is subjected.

We will refer briefly to the difference existing between cast iron, steel, and wrought iron in reference to the amount of carbon which these contain. It is well known that cast iron represents the highest degree of carbonization of these three forms of iron, containing usually over 3 per cent. of carbon; cast steel may contain from .06 per cent. to 1.5 per cent., while wrought iron, being the purest form of iron, contains only from .02 per cent. to .10 per cent. There are, however, no exact lines of division between these three forms of iron, since one form easily grades into another, and the characteristic features of the several forms mentioned are found more or less modified in all. In general, we associate with cast iron the idea of brittleness and a small amount of elasticity and ductility; while, on the other hand, wrought iron presents to us the characteristics of toughness and ductility. Steel gives us, at once, the idea of hardness and elasticity; it presents neither the brittleness of cast iron, nor the toughness of wrought iron; but combining these, gives us a material that is hard and elastic. While there are other elements which enter into and modify the constitution of iron, and adapt it to various purposes, the presence of carbon is perhaps more important, in the tempering of steel, than that of any other known element.

It is well known that from the same material may be produced cast iron, steel, or wrought iron according to the stage of the process at which the operations are arrested in their manufacture. In a general way, we understand that the heating of iron is attended to a greater or less extent with the burning of the carbon which it contains. In the manufacture of steel and malleable iron, operations are introduced that hasten the oxidation or burning out of this carbon. It is of importance to the blacksmith, however, to understand clearly that the same oxidation goes on, to a less extent, upon the surface of the iron which is heated in the forge. It is customary to see a good smith, when introducing a bar of steel into the forge, settle down his fire and carefully cover the steel. This is for the purpose of preventing the access of air to the hot bar, which would cause more rapid oxidation of the carbon in the heated surface of the steel. When a bar of iron is heated red hot and allowed to cool slowly in the air, this process of oxidation continues during the cooling; and the surface of the metal is decarbonized to a greater or less extent, rendering it soft and tough, or giving it the features of wrought iron. On the other hand, when a bar of iron is to be hardened, or as we say, given a high temper, it is heated to a bright cherry red and plunged at once into a bath to cool it suddenly; thereby preventing the oxidation of the carbon upon the surface of the metal. This gives a hardness and durability to the iron that is of great importance in the manufacture of tools. This operation of hardening is usually the first operation performed upon drill and pick steel, by the smith. It is, however, often omitted by other smiths, but we think the omission tends, in the long run, to deteriorate the steel, and reduce the general temper of the iron. The better practice is to restore the temper of the bit, when sharpening.

In the hardening of steel for cutting purposes, it is important that the bath should be of sufficient volume that the cooling be done rapidly and without danger of raising the temperature of the bath; otherwise, the hardening of the steel will not be accomplished in a thorough manner. This bath may be either pure water—rain water or soft water being preferred—or a more or less concentrated brine, or a bath of common black oil. The action of the brine or of the oil when substituted for water as a cooling bath, may be, to a certain extent, to reduce the rate of cooling; but the chief efficacy of these lies in their prevention of oxidation, during the cooling, which takes place to a limited extent in the use of water, which always contains a certain amount of air in solution. In the use of oil, there is a certain amount of carbon absorbed by the surface of the hot iron, which thereby becomes slightly carbonized and toughened as well as hardened, during the sudden cooling. This action of the oil during the cooling, is very important, in the tempering of drill steel particularly. The question was asked not long since, if hot water would be as "efficacious as oil in the cooling

of steel in tempering"? The idea being expressed that the time of cooling would be lengthened, when hot water is employed, and the same effect produced as in the use of oil, for this purpose. Our reply to this question is that the effect would not be the same, as the efficacy of the oil consists in the carbonization of the surface of the steel, during the cooling.

In the sharpening and tempering of pick steel, regard must be had by the smith to the character of work for which the tool is to be employed. Picks that are to be used in soft coal or coal of medium hardness, require toughness more than high temper. These should have a longer point than when employed in harder coal, or in rock, or among sulphur balls. Where the hardness of the material to be picked is considerable, the point of the pick should be more blunt, and its temper raised. A good miner will have on hand several kinds of picks, which he will use according to the work in hand. The point of the pick should not be drawn so fine that it tends to bind, in the coal, and takes an effort to remove it, when cutting; neither should it be so blunt as not to cut well. Different styles of points will be found applicable to different kinds of coal, and these can only be determined by the experience of the miner.

As the method of hardening, reheating, and tempering has been fully explained in a previous article (page 188, MINES AND MINERALS, November, 1899), we will not repeat the process here; the aim of this article being to draw more particular attention to what constitutes the difference in the several forms of iron; and how one form may readily be modified to assume the characteristics of another form, without due care in the handling of the hot iron.

Haulage.

(Continued from July Issue.)

Rope Haulage on Level Roads.—The subject of rope haulage upon roads that are practically level, in distinction from gravity- and engine-plane systems is divided into two general systems: (1) Tail-rope haulage. (2) Endless-rope haulage. These two systems, while they may be used at times interchangeably under the same conditions, yet each has its own adaptation to particular conditions. There is much in the consideration of the subject of rope haulage that requires experience in the operation of the system, in order to appreciate fully the several points in regard to each system. In general, a tail-rope system of haulage is better adapted to seams in which the haulage roads present various grades. This is particularly the case in many of the seams of the central basin. The coal deposits, in many localities are not continuous deposits of uniform thickness and inclination, but present numerous changes in the physical characteristics of the seams, particularly with reference to the grades of haulage roads in those seams.

In the installation of any system of mechanical haulage, it should always be the aim and endeavor to straighten the roads, and to render the grades as uniform as possible by cutting the hills and filling low places. When this has been done, however, there often remain numerous short up and down grades in the haulage road. The result of these numerous occurring grades is to throw irregular loads upon the winding engine. These varying loads thrown upon the engine in no particular order, are less easily controlled in the operation of an endless-rope system than in a tail-rope system. This is true from the fact that in the endless-rope system the loads may be all upon a down grade at once, or it may occur that they are evenly divided. The latter condition would be very favorable to the operation of the system; but there is no regularity with regard to the load, and the engineer finds great difficulty often in the proper regulation and control of his engine.

The Tail-Rope System of Haulage.

In the operation of the tail-rope system, the loaded trip occupies one place in the haulage road, instead of being distributed along its entire length, as in the endless-rope system. The trip may consist of anywhere from 5 to 25 cars, or even a greater number than this. In this system, two ropes are employed, the one called the *main rope*, running from the engine into the mine, draws the loaded trip out; while the other, called the *tail rope*, running from the engine into the mine and passing over a return sheave at the farthest point inbye of the haulage road, is used to draw the empty cars back into the mine, as well as to restrain and regulate the velocity of the loaded cars while they are being drawn out of the mine. The heaviest burden of haulage thus falls upon the main rope, which in most cases is made the heavier of the two ropes. The tail-rope

system is more pliable than the endless-rope system and possesses the advantage that the engineer is better able to control the working of the system and of his engine throughout the entire trip. The rigidity of the latter system often throws an undue strain upon the rope, and varying loads upon the engine. The operation of the tail-rope system, however, requires considerable care and tact on the part of the engineer in the control of the drum, from which the tail rope is winding off. This drum is uncoupled from the engine shaft during the unwinding, and its motion is controlled by the brake. Only sufficient slack must be given to the tail rope as is required by the movement of the loaded trip.

The general points of interest in regard to the conducting of the ropes through the mine passages will be described later in an article "Rope Transmission in Mine Haulage." It remains to speak, in this article, of the manner of conducting the winding rope from the engine to the shaft bottom, and a few other details in reference to the location of the inside parting, return sheave, etc., and to illustrate the calculation of the power required for any given tail-rope haulage.

Conducting the Ropes Into the Mine.—There are several methods of carrying the ropes from the engine into the mine. The haulage ropes are often taken down a compartment or manway in the hoisting shaft. When this is not practicable, drill holes are sometimes put down from the surface to a point in the haulage road near the shaft bottom (Figs. 1 and 2). The drill holes for this purpose are cased from top to bottom with a 2½- or 3-inch casing. Large sheaves are placed in position over the hole, and at the bottom of the hole, in the roof of the haulage road. To support the sheave pulley in the roof of the haulage road, a special heavy framing is necessary (Fig. 2). The wear upon the rope by rubbing upon the casing, in passing through a drill hole is not as great as would at first seem probable. The rope is kept well oiled, which decreases the friction and consequent wear.

In some cases, it is considered preferable to conduct the tail rope over the surface to a point immediately over the return sheave, at the inbye end of the inside parting. At this point, a drill hole is located and bored, and the necessary sheaves placed in position above and below. This method possesses several advantages and some disadvantages. The advantages are, a shorter rope is required; there is less wear and tear in transmission on account of the course of the rope being more direct; and the annoyance of the rollers and sheaves in the entries is avoided. The rope, however, upon the surface is exposed to the weather, and is subject to sudden changes of temperature from the warmer air of the mine to the cool outside air, or from the cold of the atmosphere to the heat of the engine room. In the transmission of a rope over the surface, large trestles are necessary in order to elevate the rope to a sufficient height to avoid any damage to cattle or otherwise.

The return sheave is shown in Fig. 3, and is located at the inbye end of the inside parting. This sheave must be firmly braced against the roof and floor, to withstand the pull of the entire loaded trip; since it may be necessary, at any time, to bring the outgoing loaded trip to a standstill at any point in the mine; or it may be necessary to pull the return trip back a short distance, upon the steepest grade in the mine. Not only must the return sheave be able to withstand the pull necessary for this work, but the tail rope itself must be of a size and strength sufficient to withstand the load thus thrown upon it. A heavy framing is usually set at the point where the return sheave is located, to support the roof and prevent a fall at this point. Two upright posts are then set, side by side, behind this framing, the upper ends of the uprights being set into the roof, and the lower ends being sunk into the floor. If necessary a heavy cross-sill is placed in the floor in front of the uprights to give them a good bearing. If the tail rope is carried over the surface and enters the mine at the return sheave, as shown in Fig. 3, these uprights should be inclined somewhat backwards, so that the reaction from the pull of the vertical and horizontal ropes shall be nearly normal to the timbers carrying the sheave. The purpose of this is to relieve the journals of the load which would otherwise be thrown upon them. When the uprights, however, are inclined in this manner a strong brace should be introduced, to prevent the foot of the upright from lifting the bottom. These braces should extend from the foot of the upright forward to a point in the roof as

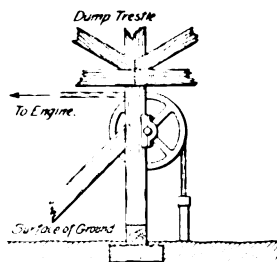


FIG. 1.

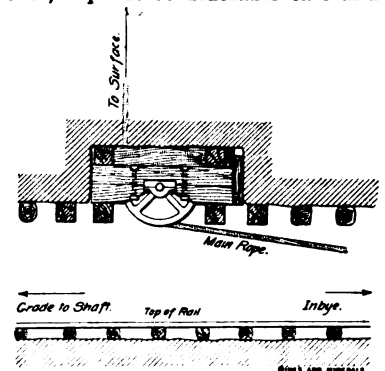


FIG. 2.

shown in the figure. The location of the return sheave should be such that the tail rope may be readily carried under the empty track where this turns from the main track, to form the side track, at the parting. Suitable guide sheaves and rollers are placed between the two tracks of the parting, for this rope. The form of tail sheave shown in Fig. 4 is sometimes used, when the tail rope is conducted into the mine at the shaft, and carried along the haulageway. This sheave is located beneath the empty track, at the inbye end of the parting, but is not as convenient as the tail sheave shown in Fig. 3.

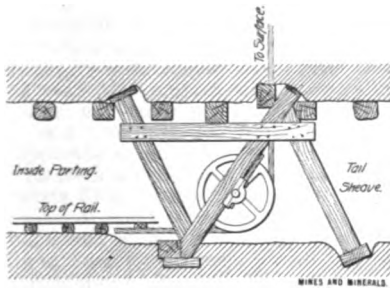


FIG. 3.

depends upon two factors only. (1) The tension upon the rope. (2) Speed of winding. In the installment of any proposed rope haulage, we should estimate upon the power which will be required under any conditions that are liable to occur. Regard must be had to the future development and extension of the haulage system, as well as to steeper grades, that may be encountered.

1. *Load Upon the Haulage Rope at the Winding Drum.*—It is customary to consider the main rope and tail rope separately in determining the loads upon each of them. The tail rope is often made the lighter of the two ropes; since, as is argued, this rope is required only to haul the empty cars back into the mine. We regard this as a serious error, for the reason that the tail rope should possess strength sufficient to enable it to control the loaded trip upon the steepest grade in the mine. It may become necessary at any time, to bring the loaded trip to a standstill upon its outward journey, or to haul this trip back a short distance into the mine. This emergency may occur upon the steepest grade of the road. The tail rope should obviously be strong enough to perform this work. The objection to making the tail rope of the same size as the main rope is practically, however, of little importance, since in the operation of the system it is customary, and we may say good practice, when it becomes necessary to order a new rope, to make the main rope, which is becoming worn, the future tail rope, and to order a new main rope. This can always be done readily when the ropes are conducted into the mine at the shaft and carried along the haulway.

Where the tail rope is carried over the surface and dropped into the mine at the tail-rope sheave, it would be necessary in order to make the change proposed, to couple the inbye end of the main rope to the tail rope, and draw it up through the drill hole at the tail sheave to the surface and back to the winding drum. In this case, the main rope will always be long enough to be used as a tail rope, and there will be a piece that will have to be cut off from it, in almost every instance; since the course of the tail rope over the surface is more direct than that below ground. It will be necessary, in the adoption of this method, when the ropes are both conducted through the haulageways, to always order a length of main rope slightly longer than that required, in order that it may be long enough to pass over the tail sheave when used as a tail rope. However, these matters are of little importance, since the estimate of the length of the rope should always be ample to provide for some splicing. We mention them here as a safeguard only. The extra length can usually be coiled away inside of the winding drum, if necessary.

In estimating the load upon the rope at the winding drum, we must consider the following factors. (a) The weight of the rope hanging in the shaft or drill hole. (b) The gravity pull due to the loaded trip upon the steepest grade in the mine. (c) The friction of the entire system, including rolling friction of the loaded trip and that of the rope.

This calculation should be made on the assumption that the rope is a tail rope, provided the steepest grade occurs when the movement of the trip is inbye. Indicating as follows:

- T = tension or pull upon rope (lb.);
- W = weight of loaded trip (lb.);
- w = weight of rope per lineal foot (lb.);
- l = length of both ropes; equals 2 times the distance from winding drum to tail sheave (ft.);
- d = vertical drop of rope (ft.);
- a = slope angle of maximum grade.

We have for the weight of rope in shaft $w d$; the gravity pull and friction pull of the loaded trip, $W \left(\sin a + \frac{\cos a}{40} \right)$; and for

the friction of the rope $\frac{wl}{40}$. We assume that the loaded trip is upon the maximum grade in the mine, whether this grade is an inbye or an outbye grade. We calculate the friction for the entire length of both ropes but assume that the gravity pulls of the rope upon the several grades balance each other. The entire length of rope is twice the distance from the winding drum to the tail sheave. It is to be observed that the weight of the descending rope does not balance the weight of the ascending rope, in the shaft, in this system of haulage, since the drum from which the rope is unwinding is always uncoupled from the drum shaft, and its motion controlled by the brake. The engine must, therefore, always lift the dead weight of the ascending rope, in the shaft. Combining the above expressions, we have for the load upon the rope,

$$T = W \left(\sin a + \frac{\cos a}{40} \right) + w \left(d + \frac{l}{40} \right).$$

From this tension or pull, the size of the rope is determined, using a factor of safety of say 4 or 5. A greater factor of safety may be used, if desired, in order to increase the time the rope will wear, or the life of the rope.

EXAMPLE.—What size of steel wire rope will be required to haul a trip of 20 mine cars, the weight of the loaded cars being 3,000 pounds each, the depth of the shaft being 300 feet, and the distance from the foot of the shaft to the tail sheave 900 yards; the maximum grade in this haulage being 10° ?

SOLUTION.—Substituting the given values in the above equation, we have for the pull upon the rope at the winding drum, in this case, assuming for the present a $\frac{3}{4}$ -inch rope weighing .88 pound per lineal foot,

$$T = 60,000 \left(.17365 + \frac{.9848}{40} \right) + .88 \left(300 + \frac{6,000}{40} \right) = \text{say } 12,300 \text{ lb.}$$

or somewhat over 6 tons.

Referring to the tables for steel haulage ropes with six strands of seven wires each, we find the breaking strain of a $\frac{3}{4}$ -inch rope, weighing .88 pound per lineal foot, is 24 tons, which will give a factor of safety of about 4. We would prefer, however, in this haulage to use a $\frac{7}{8}$ -inch or even a 1 inch rope, as a change of ropes would then be required less often.

Making the necessary corrections for a 1-inch rope weighing 1.58 pounds per lineal foot, we find for the pull upon the rope, in this case,

$$T = 12,607 \text{ lb.}$$

2. *Speed of Winding.*—The speed of winding, in any system of haulage, must be determined after considering the condition of the haulageways and the rolling stock, in connection with the grades and the desired output. The first step in this problem is to determine the size of the trip, or the number of cars or weight of coal to be hauled in each trip. The capacity of the mine cars is usually fixed to a great extent by the character of the seam; thin seams requiring cars of small capacity; poor roof requiring narrow cars; while thick seams admit of cars of greatly increased size and capacity. The number of cars that can be hauled in a trip is very largely dependent upon the character of the roadway and the rolling stock, the number and degree of curves, etc. Where track and cars are in excellent condition, trips of 25 or 27 cars may be hauled, by a careful and observing engineer. These considerations determine the weight of coal which it is advisable to haul per trip, in any given case. Having determined this, the speed of winding and the length of haul are the two remaining factors which determine the output of the mine. The speed of winding is also dependent upon the condition of the roadway and rolling stock. Under ordinary conditions of mine haulage, it is not advisable or safe to increase the speed of winding much beyond that of 12 miles per hour; although, when the track and cars are in good condition and the road fairly straight, this speed

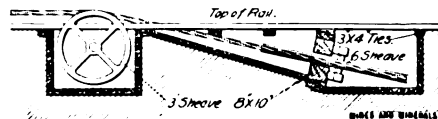


FIG. 4.

may be exceeded to some extent in tail-rope haulage. A speed of 12 miles an hour is

$$\frac{12 \times 5,280}{60} = 1,056 \text{ ft. per min.}$$

Assuming here a speed of 12 miles per hour, the power required for haulage, in the previous example, is calculated thus,

$$\frac{12,607 \times 1,056}{33,000} = 403.4 \text{ H. P.}$$

Size of Engine.—Before we can calculate the size of engine required for this haulage, we must determine the diameter of the winding drum. We have used a 1-inch steel rope of seven wires in each strand. The minimum sheave required for this rope is a sheave of 77-inch diameter. The diameter of the drum must, therefore, not be less than 77 inches, and we will assume for its diameter 80 inches.

Then, $\frac{1,056 \times 12}{80 \times 3.1416} = 50.416$ revolutions per minute, for the speed of the drum. If we make the ratio of gearing $\frac{\text{diam. of drum gear wheel}}{\text{diam. of pinion}} = \frac{3}{1}$, the engine will be required to make $50.416 \times 3 \times 2 = 302.5$ strokes per minute.

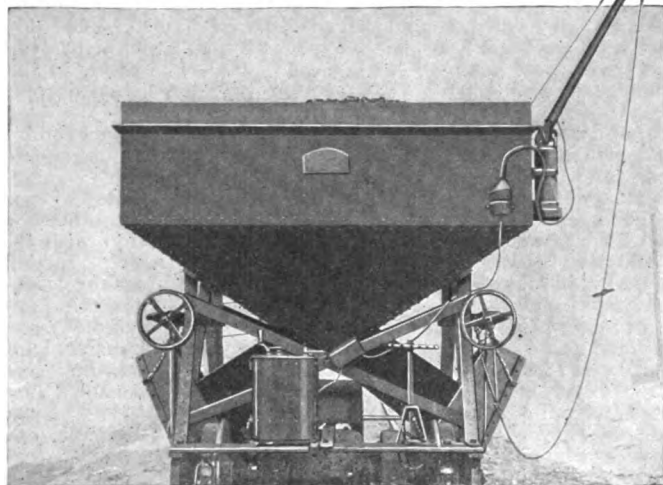
Then, assuming a mean effective cylinder pressure of, say 50 pounds per square inch, and using the formula given upon page 379, *MINES AND MINERALS*, March, 1900, making the ratio between the diameter of cylinder and length of stroke 1, we have for the diameter of cylinder,

$$d = \sqrt[3]{\frac{2LD}{pr_1}} = \sqrt[3]{\frac{2 \times 12,607 \times 80}{50 \times 1 \times 3}} = 23.78 \text{ in., or, say 24 in.}$$

Hence, the size of the duplex second-motion engine required for this haulage, will be 24 in. $\times$ 24 in.; speed 302.5 strokes per minute.

Electrically Operated Coke "Larries."

The extraordinary activity of the coke industry, due to the increased demand for coke in the iron and steel manufactures, illustrates again the law of supply and demand, the latter being so much greater than the former that it would be difficult to find an idle oven, and hundreds of new ovens are being rapidly pushed to completion. The coke manufacturer will, for some time to come, find a ready market for his maximum output, and any auxiliary that will facilitate, and at the same time cheapen, production should



receive a most welcome reception. This is a general statement true of every line of manufacture, and is characteristic of American manufacturing methods, the enterprising producer having small compunctions about discarding time-honored apparatus and systems for more modern and efficient equipments.

The manufacture of coke requires a certain minimum time, usually 48 hours for "furnace coke" and 72 hours for "foundry coke," but the quality of the coke suffers if the processes are too closely curtailed. The by-product oven is by no means an assured success, although interesting developments may be expected in that direction in the future. It is obvious, therefore, that radical improvements are immediately possible in the methods of handling the coal and coke, rather than in the processes which take place in the ovens themselves, therefore some method of charging the ovens more quickly seemed necessary. Due to the conditions under which the larry has to operate, at first there seemed to be little chance of improvement at this point and the owners of coal mines operating coke ovens did not see any promise of better results by the application of electricity to the operating of the larries, but practical experience has shown that the electrically propelled larry is the means of a large saving in both time and labor, and the results obtained from the several electric larries in operation are most gratifying. The equipment consists of a standard railway motor, of the enclosed type mounted on one of the axles, controller, and trolley, and may be applied to larries at present

drawn by animal power, it being unnecessary to design a special larry adapted for the electrical equipment. The control is so perfect that when about to discharge its load into the ovens, the larry may be moved in either direction literally "an inch at a time," and a much higher speed is possible than with horses or mules. The result is a surprising saving in time in hauling from and returning to the tipple, and in discharging the coal at the ovens. The "trolley" or "third rail" system, preferably the latter, may be used to convey the power to the motor, and the approaches to the ovens may be much more cheaply constructed, as it is unnecessary to provide a path for the horses or mules.

One electrically equipped larry with its operator will easily do the work of two mule larries with their drivers, and when the conditions permit, the electric larry may supply the motive power for other larries, which, operated as "trailers," may be dropped at the proper places, having been loaded at the tipple, and picked up on the return, in the meantime having discharged their loads into the ovens. The increased adoption of electric mining locomotives and electric motors for driving pumps, hoists, car conveyors, blowers, etc., should be considered in connection with the installation of a dynamo for the operation of coke larries, but even if the conditions are such as to debar other applications of electricity, the investment will show a very good return. At many mines generating plants are already installed, in which cases the additional investment would be very small indeed, and the saving in cost of operation would soon pay for the electrical equipment of the larry. The General Electric Co. offers for this work its standard railway motors and magnetic blow-out controllers, embodying the results of years of experience in the field of electric traction. The many advantages of using standard apparatus are obvious, and the subject is one that merits careful investigation on the part of the coke manufacturer.

While the electric larry possesses many points of superiority, the best argument in its favor is the consequent reduction in expenses. That such a reduction is effected is clearly shown by the following figures, which were submitted by a prominent coke manufacturer:

Cost per oven, horse haulage	.0583
Cost per oven, operation electric	.0829
Cost per oven, power-house expenses	.0058— .0887
Net saving per oven	.0196

It should be noted in this case that the saving amounts to 33.5 per cent. of the cost per oven of horse haulage.

Mines and Mining in Yavapai County, Arizona.

The prediction of Humboldt, that the mineral wealth of the world would be found in Arizona and New Mexico seems to be verified today. The correctness of that opinion seems to have been demonstrated. Mines that have been idle for years are once more resounding with the miner's pick and shovel, and a general waking up and activity is noticeable throughout the mining districts. More gold has been produced than ever before in the history of the county, and, what is even better, mining men have finally realized that this is the country of deep mining. The completion of the North and South Railroad has solved the problem of working the mines economically, and the industry is now entering upon its greatest era. New capital is coming in to develop the great properties of the county, and the production of the precious metals is increasing daily.

With legitimate mines there has come a change in the scene, and the old has been pushed aside for the new, the benefit of which is today attested in this vicinity by the number of men on the ground and the manner in which they are operating. It is such an improvement over the played-out past, and the country is now being so firmly and legitimately handled in the practical and energetic work that goes with deep mining as to give us greater consideration, probably, than any other section of the Southwest.

The past five years have seemingly solved the future of this county as a mining section, and if only one-half of the mines being developed prove successful, Yavapai will be the most prosperous field for mining of any subdivision of the Union. Although one of the oldest mining sections in Arizona, it is nevertheless, in a practical sense, the newest.

Ten years ago there were not half a dozen gold claims in this section that had a 250-foot shaft, and in silver mines not many more. Today, in any district the opposite prevails, and when we look around and size up the miles of underground shafts and drifts in the United Verde, the 2,400-foot main shaft in the Congress, the thousands of feet of the Crowned King, the McCabe, the Jessie, the Empire, the Senator, the Poland Hamilton, Del Pasco, the Gladiator, the Favorite, the Peery, the Henrietta, the Accident, and especially the Planet Saturn, that has struck it at 1,000 feet richer than ever, the Johnson mine, and dozens of good prospects in the vicinity of Rich Hill in Weaver district, besides many others, we realize that the country asks to be "showed up."—Report of the Governor of Arizona.

NEW INVENTIONS.

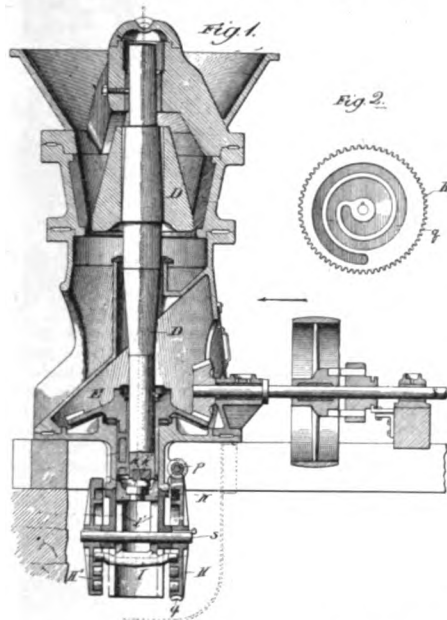
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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CRUSHING MILL.

No. 650,097. M. J. E. ROTTER, CHICAGO, ILL. Patented May 22, 1900. This invention relates to a device for adjusting the crushing space of a gyratory crusher, and is illustrated by the accompanying figures. The

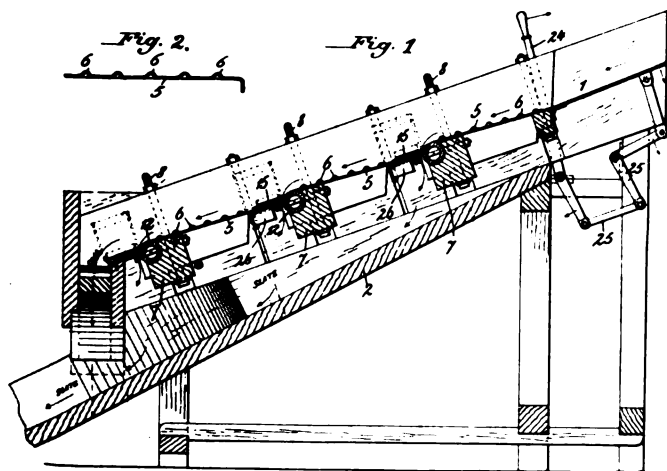


adjustment is accomplished by raising and lowering the spindle D with its crushing head D'. This is accomplished by means of a pair of cams H and H', one of which is shown in detail in Fig. 2. One of the cams H is provided with worm teeth q about its outer periphery, and these teeth are engaged by the worm P so that both cams and their connecting shaft S can be rotated at will. The yoke I has rollers riding in the cams on each side, and is carried up and down by the cams. This yoke supports a movable sleeve K having slots l' through which the shaft S passes. This sleeve carries the ordinary

thrust bearing k which supports the shaft D. One of the special advantages claimed for this device is that it is compact, and does not require a large amount of space below the crusher.

COAL SEPARATOR.

No. 650,120. CHARLES W. ZIEGLER, SCRANTON, PA. Patented May 22, 1900. The slate picker covered by this patent is illustrated by the accompanying figures, in which 7 is an inclined perforated plate over

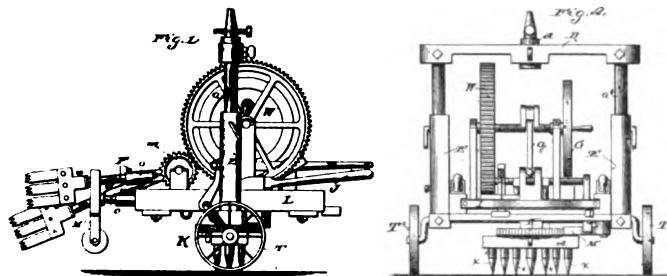


which coal and slate slides to the picker. The picker proper is composed of inclined plates 5 having serrations or projections 6 on the upper face, as shown more clearly in Fig. 2. These plates 5 are attached to blocks 7 which are adjusted separately by means of bolts 8. At one edge of the blocks, pipes or tubes 12 are inserted so that the plates butt against them and there is a small space left between the tube and the upper edge of the next plate. This space is partially closed by the adjustable slide 15, the upper edge of which is turned down as shown. The object of this

downward bend at the upper edge of the plate is to prevent any thin pieces of slate from lodging between the plates 5 and 15. The coal attains a sufficient momentum so that it jumps the space between the tube and the shield 15 and passes on down over all the spaces to the bottom of the machine, where it is discharged through the chute as shown. The slate falls through the spaces below the tubes 12 into the chute 2. The plate 7 in the receiving chute is arranged so that its angle may be changed by means of a series of levers 25 and a hand lever 24, and the angle of the plates 5 may be varied to a certain extent by raising or lowering the supporting piece 26, which is accomplished by means of a set of links and levers on the outside of the machine.

MACHINE FOR UNDERCUTTING COAL.

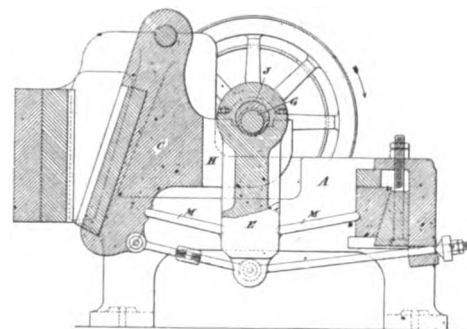
No. 651,768. A. OCHTINSKY, ROCKVALE, COL. Patented June 12, 1900. The machine covered by this patent is shown in Figs. 1 and 2. The mechanism is supported between two columns E which are provided



with sliding pieces a. These sliding pieces are connected across the top by the yoke D, having a central pin d to engage with the roof. The machine is provided with wheels T for removing it from one place to another, and with spikes x for securing it to the ground in any desired position. These spikes are upon bars d carried by the ratchet wheel K so arranged that the machine may be rotated about a central vertical axis by means of the ratchet M. The picks are mounted upon bars O having a telescopic portion g so arranged that they can be extended. This portion g works through the guide M'. The picks are operated by means of cranks upon a shaft in front of the machine. The shaft is driven by the pinion m from the gear W which, in turn, may be driven by a crank from the hand wheel G or by means of the lever v and the pitman q. All of the operating mechanism is mounted upon the slide l, which can be moved forward in the frame L by means of suitable ratchets, so as to force the cutters to their work. The machine is wheeled from place to place upon the wheels T by means of the handles J.

OPERATING MECHANISM FOR STONE OR ORE CRUSHERS.

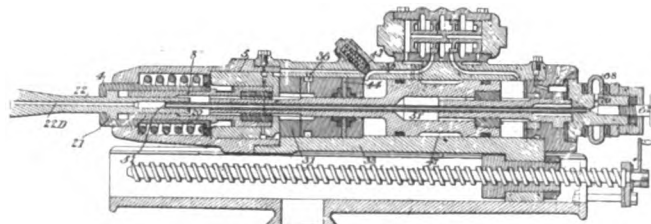
No. 650,121. W. H. BAXTER, HARBURG, ENG. Patented May 22, 1900. This patent covers an especial method of supporting the shaft in a crusher of the Blake pattern, and is fully illustrated by the accompanying figure. In place of



mounting the driving shaft G in solid bearings upon the frame A it is mounted in bearings upon the lugs H, which are attached to the movable jaw C. The shaft G is provided, as shown, with an eccentric J and connected with the toggles M by means of the pitman E. The result of this arrangement is that the movable jaw has force applied to it not only by the toggles M but also through the lugs H from the driving shaft. The inventor claims to thus reduce the amount of power necessary for crushing the material. He also claims the right to apply this principle to punches, shears, and similar machines.

ROCK-DRILLING ENGINE.

No. 651,487. J. G. LEYNER, DENVER, COL. Patented June 12, 1900. This patent has two objects in view, one is to provide a means of forcing

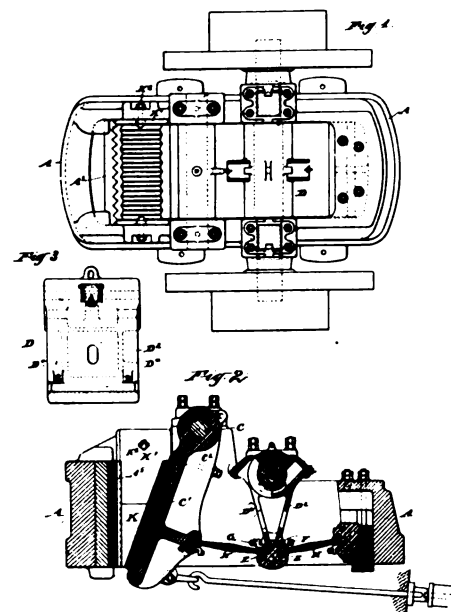


water or other similar liquid in combination with the operating fluid of the machine (which may be steam or air) down through the center

of the drill and bit so as to wash the cuttings from the hole. In the accompanying figure, 22 represents the bit, through which is arranged the hole 22 D. The tube 51 passes down through the drill piston and other mechanism and connects with the center of the drill 22, the water being introduced through the opening 70 from the chamber 63 and the flow controlled by the valve 62. The drill has the ordinary standard feed mechanism, consisting of a crank and a feed screw for removing the entire drilling engine forward upon its mountings. The drills are provided with lugs 21 and are introduced into the machine through the slots in the piece 4. After they are introduced, the piece 4 is partially rotated so as to close the slots through which the lugs entered. The other novel feature of this machine, aside from the water feature, consists in the fact that the drill 22 is not connected rigidly to the piston 47, but the piston operates the piece 8 by means of the hammer bar connected to the end of the piston and the interposed spring washers, and by this means operates the drill, the piston being free to return without having to drag the drill with it. A small portion of the air in the cylinder at the end of the stroke is forced from the port 33 through the spring relief valve 41 into the port 36 which communicates with the space 20 at the head of the drill. This air forces its way around the tube 51 and mingles with the water which has passed down through the tube into the top of the drill 22, so that the mixture of air and water passes down through the drill together.

ROCK CRUSHER.

No. 650,105. E. C. BACON, NEW YORK. Patented May 22, 1900. This invention relates to a crusher of the Blake type, and consists in improvements in the pitman and the manner of securing the various parts so as to prevent their becoming displaced. It is illustrated in the accompanying figures, in which A is the crushing frame of ordinary construction. The pitman D is of special design to enable it to resist the tension to which it is subjected, and at the same time to reduce the weight to a minimum. Fig. 3 shows a detail of the pitman which will make the upper portions of its construction plain. Instead of having a solid casting it is composed of two webs D² which are practically tangent to the eccentric head or strap at the top, and are united at the bottom so as to form a support for the toggle joints E. These webs D² are connected by transverse webs D⁴ in order to secure additional stiffness and strength. The head of the toggle is provided with a special oiling pocket having a hinged cover with a suitable device for securing the same, as is clearly shown in Figs. 2 and 3. The toggle plates H rest in bearings E on the end of the pitman, and are secured from longitudinal movement by lugs near their center, which fit into corresponding recesses and bearing pieces E. The bearing pieces E are held in place by wedges F secured by a through bolt G, and at the other end of the toggle plates similar bearing pieces are also held in place by wedges and bolts as shown in Fig. 1. The movable jaw C' oscillates upon the shaft C. In order to prevent longitudinal travel of the shaft it is provided with pins C² which fit into the bearings and caps upon the frame A, thus preventing the shaft either from rotating or traveling longitudinally. The filling or cheek plate K of a crusher usually wears rapidly, and also sometimes gives trouble by working loose and thus allowing the fixed plate A² to play up and down. To secure this plate firmly in position, and at the same time allow its ready renewal, the follower piece K' is introduced, which is bolted to the frame K

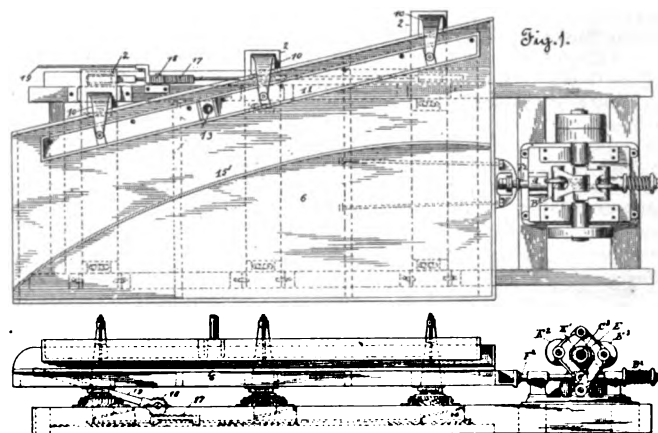


of the crusher. The bolt K² which secures the follower piece passes through slots in both the follower piece and the crusher frame, these slots being placed at right angles so that there is sure to be an opening at their intersection through which the bolt can pass, even though the castings themselves may be quite badly out of shape.

ORE CONCENTRATOR.

No. 650,673. W. G. DODD, SAN FRANCISCO, CAL. Patented May 29, 1900. The concentrator covered by this patent is of the movable or shaking-table type usually called vanners, and is illustrated by Figs. 1 and 2. The table 6 is mounted upon ball bearings and arranged so that the incline from front to back can be adjusted by means of wedges 14 under the ends 2 of the supporting timbers, these wedges being controlled by means of the rack 17, pinion 18, and lever 19. A reciprocating motion is given to the table by means of a driving mechanism, as shown at the right-hand end of the figure. In this driving mechanism a shaft C² is provided with two eccentrics E and E', which bear against

two rollers E² and E³. By varying the total throw of these eccentrics, by turning them toward or from one another, the amount of travel of the rollers or bearings E² and E³ may be regulated. These bearings are kept constantly in contact with the eccentrics by means of the spring D², and as they are pressed apart the table is forced back by the lever B² and the rod F². As the eccentric advances the lever is allowed to return and the spring quickly returns the table to its position. In the style shown in the illustration a single riffle 15' is used upon the table, and this is given a curved outline or shape similar to



that which would be assumed by the concentrates in passing down the table. The material to be treated is introduced into the trough 11, which is supported by brackets 10, the pulp being introduced at the upper end of the trough and the water through the pipe 13. The advantage claimed for the use of a single riffle is that where a number of riffles are employed the valuable constituents of the ore in passing over them are agitated to such an extent that the fine or valuable portions, such as float gold, are brought to the surface and floated away while by maintaining them behind a single properly placed riffle they can be saved, though the patent states that there is no objection to using other riffles farther down the table if deemed necessary, the principal claims being for the driving mechanism and the methods of support, operation, etc.

PATENTS ISSUED DURING JUNE AND NOT ILLUSTRATED.

- No. 650,918. Regenerative furnace, Wm. Swindel, Allegheny, Pa.
- No. 650,988. Discharging mechanism for rotating boring rods, A. Raky, Erkelenz, Germany.
- No. 651,006. Concentrator, S. T. Curtis, Virginia City, Nev.
- No. 651,022. Apparatus for separating gold from sand, J. P. Sterling, Kansas City, Mo.
- No. 651,065. Raddle for conveyors, G. F. Conner, Port Huron, Mich.
- No. 651,241. Endless-belt conveyor, J. M. Dodge, Philadelphia, Pa.
- No. 651,330. Stone-sawing apparatus, Wm. Harvey, Denver, Col.
- No. 651,506. Barrel amalgamation of precious metals, E. Heiligen-dorfer, Canelas, Mex.
- No. 651,509. Precipitation of precious metals from cyanide solutions, F. W. Martino and F. Stubbs, Sheffield, Eng.
- No. 651,510. Treatment of ores and precipitation of precious metals from their cyanide solutions, F. W. Martino and F. Stubbs, Sheffield, Eng.
- No. 651,589. Bit or chisel for channeling stone, J. Barker and F. C. Smith, McDermott, Ohio.
- No. 651,718. Method of electrically treating ores of nickel, etc., H. Leleux, Paris, France.
- No. 651,722. Fuel press, G. W. Murphy, Northfield, Minn.
- No. 651,767. Machinery or apparatus for dividing, shaping, working, or dressing stone, F. M. McLarty, Greenock, Scotland.
- No. 651,822. Apparatus for cleaning or washing pyrites or other minerals, C. Burnett, The Grange, and H. T. Newbigin, Newcastle-upon-Tyne, Eng.
- No. 651,939. Fuse igniter, M. O. Smith, Springfield, Ill.
- No. 652,004. Hand well-drilling machine, G. D. Loomis, Tiffin, Ohio.
- No. 652,072. Treatment of ore, G. de Bechl, Paris, France.
- No. 652,076. High-temperature smelting furnace, W. Borchers, Aix-la-Chapelle, Germany.
- No. 652,193. Furnace for roasting ores, H. B. Meech, Denver, Col.
- No. 652,208. Crushing mill, R. A. Hadfield and A. G. M. Jack, Sheffield, Eng.
- No. 650,581. Amalgamator, A. M. Ernsberger, New York, N. Y.
- No. 650,596. Pig ejector, F. L. White and M. G. Semple, Pittsburg, Pa.
- No. 650,642. Hoisting bucket, J. E. Henry, Sheboygan, Wis.
- No. 650,646. Apparatus for electrolytic reduction of ores, F. H. Long, Chicago, Ill.
- No. 650,782. Grinding mill, R. Ellin, Yonkers, N. Y.
- No. 650,784. Method of leaching copper ores, J. W. Neill, Salt Lake City, Utah.
- No. 651,781. Dredging apparatus, G. M. Esterly and G. W. Esterly Washington, D. C.
- No. 651,798. Pulverizing mill, J. H. Elspass, Pueblo, Col.

Mines and Minerals

A MINING AND METALLURGICAL JOURNAL.

Vol. XXL—No. 2.

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COKING PLANT

Of the Durham Coal & Coke Co., Situated on Lookout Mountain,
Dade and Walker Counties, Georgia.

Written for MINES AND MINERALS, by A. W. Evans, Superintendent Chickamauga Coal & Coke Co.

The mining property of the Durham Coal & Coke Co. is situated in Walker and Dade counties, Georgia, on Lookout Mountain, the Durham coal outcropping on an eminence known as Round Mountain, 1,849 feet above mean tide.

Only a remnant of the coal measures exists in Northwestern Georgia, constituting the plateaus of Lookout and Sand mountains. The coal measures embracing an area of 116 square miles.

Lookout Mountain consists of a plateau encircled by a wall of conglomerates. Above this a higher plateau remains, forming the coal measures. The correlation of the Georgia coals with those of other Southern States is not satisfactory, and the question is involved in a conflict of opinions, yet on first examination the Georgia coal field appears to be a continuation of the Tennessee coal field. The coal field of Georgia has suffered from geological causes, and the agencies of erosion have obliterated a large percentage of the original deposit.

The amount of coal in the Durham seam is a fixed, definite quantity. Above the horizon of conglomerate, five seams of coal occur, but the Durham seam is the only one of any consequence. Its position is 615 feet above the conglomerate, and a chemical analysis by Mr. Theodore F. Jewell, Commander, U. S. Navy, Washington, gives the following result:

Moisture	0.310
Non-combustible volatile matter	1.330
Combustible volatile matter	14.594
Fixed carbon	80.084
Sulphur	0.176
Ash	2.922

General Structure of the Coal Field.—The dip at the mines is less than 1°. At any point in the coal field, where the bedded rocks are exposed, it appears that the rocks lie perfectly horizontal. On the eastern side of Lookout plateau, the strata dip northward, increasing to 12° or more. Northward the strata dip at much greater angles but flatten out toward Lookout point. So also they flatten out southward, in consequence of which the seams in the central portion of the mountain lie at low angles.

The Durham coal is 48 inches thick, with a persistent parting of fireclay ranging in thickness from 6 inches to 36 inches. This coal is of exceptional purity, and its specific gravity is 1.28. The coal is soft and friable, has no distinct cleavages, but inheriting a low percentage of ash and sulphur it is pre-eminently a coking coal.

The mining plant is located on lot 315 in Walker County, and is reached by the Chattanooga & Durham Railroad, 17 miles west of Chickamauga. The eastern terminus of the road is at an elevation of 1,810 feet above mean tide. This road furnishes a splendid means of getting the section of the coal measures. The mine is worked on the pillar-and-room system, entries being driven at convenient distances, usually at right angles to the main haulage entry. Then on each side rectangular rooms are worked out. At present the main No. 1 entry is driven about 5,000 feet.

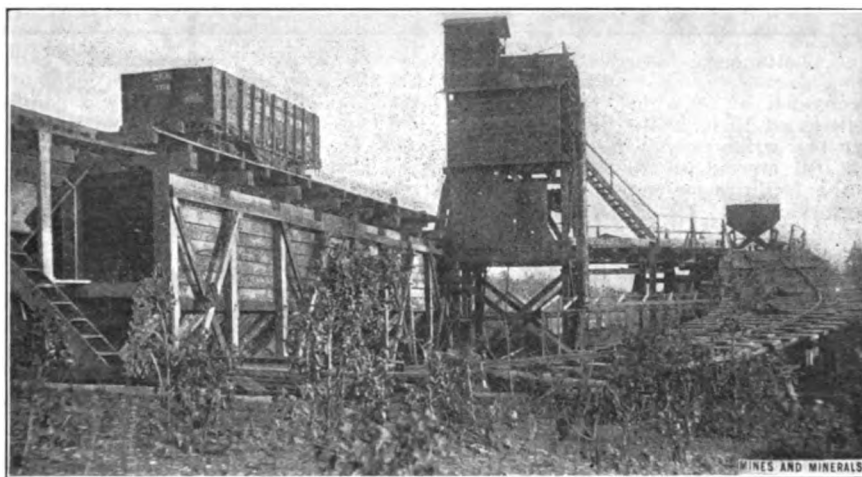


FIG. 1. HEADFRAME, BIN, AND TRESTLE, DURHAM COAL & COKE CO.

The coal from the three openings is delivered at one central point for tipping and washing. The coal, after leaving the car, passes over bar screens, spaced 2 inches apart, and at an angle of 38°; the fine coal falls into a retention bin, from which point it is carried by suitable machinery to a 400-ton Robinson-Jeffrey coal washer. Here it is freed of slate and other impurities and is then conveyed to a settling bin, from whence it is loaded into railroad cars for the coke plant at Chickamauga.

The coke plant consists of 101 12 ft. × 7 ft. beehive ovens in one continuous battery 716 feet in length. The bank of ovens

is on a 1-per-cent. grade, the coke wharfs are 30 feet wide and 4 feet above coke tracks. The larry track is laid with 56-pound rail, using long spliced joints, track supported by brick piers. The ovens are "staggered." The dimensions of retaining walls are as follows: Width, 32.25 feet; height, 9.25 feet, with a batter of 2.6 inches per vertical foot. The base of the retaining walls is 3.5 feet. The ovens are spaced 13 feet 6 $\frac{1}{2}$ inches on centers, and are perfectly circular. The absence of the long "neck," as in the old style ovens, makes this style of oven desirable, as the cost of repairs is low, the masonry of retaining walls remaining intact no matter what kind of repairs the oven proper is undergoing. For this style and size of oven it requires the following material:

For dome, 100 9-inch skews.
Bottoms, 120 12 in. $\times$ 12 in. $\times$ 3 in. tile.
Door, 12 No. 7 jambs.
Door, 12 No. 8 jambs.
Door, 9 No. 9 arch.
Ring walls, 1,450 No. 1 regular key.
Crown, 2,450 No. 1 C key.
Pillars and footings, 1,000 common hard-burned bricks.
1 eyebolt or charging port ring.
1 $\frac{1}{2}$ tons of fireclay.
Castings, 1,188 pounds.

The door casting in position is "flush" with inside radial lines of ovens, the top resting against cast-iron arch frames 5 feet 10 inches long, supporting arch in masonry of retaining walls above the door. The recess in masonry at oven door is 2 feet 7 inches in width, and flares to 5 $\frac{1}{2}$ feet at front of wall at bottom, and 4 $\frac{1}{2}$ feet at the top, this opening is 6 feet in height.

From the bottom of oven there is an apron of masonry which causes the coke, when drawn, to fall at front of retaining

with 10 in. $\times$ 14 in. cylinders. A loose drum 29 inches in diameter by 30 inches long, mounted on a 3 $\frac{1}{2}$ -inch shaft receives the rope. The engine is geared to drum in the ratio of 4 to 1.

There is a powerful friction clutch on main drum shaft connected by proper levers and convenient to the engineer. This engine was built by the S. Flory Mfg. Co., of Bangor, Pa.

The larry is of the double-discharge type and weighs 6,970

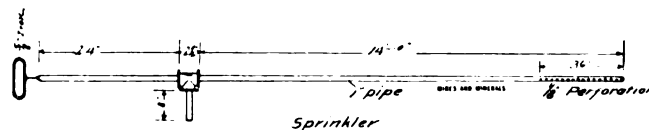
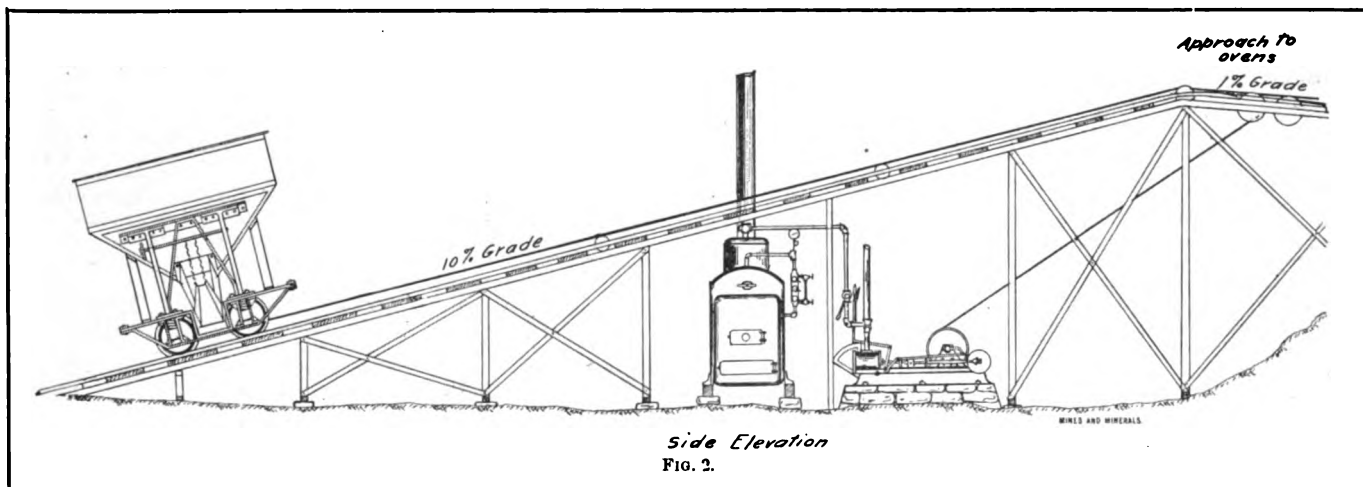


Fig. 3.

pounds. The method of operation is as follows: The larry being at loading terminals, the clutch engages the drum, then steam is admitted to the cylinders and the car moves up the 10-per-cent. grade with its load of 7 tons of coal at the rate of 348 feet per minute. The strain on the rope is 2,365 pounds, and the actual horsepower developed 35 $\frac{1}{2}$. When the car reaches the "knuckle," steam is cut off, the clutch thrown out, and it runs by gravity to oven to be charged, when the brake on car is applied.

After the car is emptied, the attendant signals the engineer by means of electric signals, the clutch is "thrown in" and engages the drum, steam is admitted to cylinders until the larry gets within 25 or 30 feet of knuckle, the speed is accelerated for a short distance, then steam is cut off, clutch thrown out, and the



wall. Montague & Co., of Chattanooga, have all patterns for shaped brick.

The original plant consisted of 50 ovens, and the coal-handling machinery was designed to expedite the charging of 25 ovens per day. After the writer assumed charge of the operating department and had erected 51 additional ovens, it was made manifest that the facilities for charging ovens were wholly inadequate for the service.

The method of charging the ovens was as follows: The washed-coal cars were run out on a spur track on a 2-per-cent. grade gaining sufficient elevation for a retention bin 70 feet long by 18 feet in height, into which the washed coal was delivered. Underneath this bin, and running its entire length, was a 12-inch cast special conveyor which delivered the coal to an elevator with buckets 6 in. $\times$ 8 in. spaced 26 inches apart. This elevator delivered the coal into a small bin above larry track, with proper elevation for larry to receive the coal. From this point the larry would run by gravity. The machinery was actuated by a small upright engine too light for the service.

The approach to ovens, retention bin, and headframe of elevator, with trestle of present arrangement for charging can be seen in Fig. 1.

The present arrangement consists of a trestle, leading from east end of ovens on a 10-per-cent. grade, consuming an angle of 90° by a curve of 40 feet radius, approaching the loading terminal. Deflecting curve sheaves are placed at proper distances apart on this curve. Ten feet west of apex of angle formed by the 10 per-cent. grade of inclined trestle and the 1-per-cent. grade of original larry track trestle, are placed two 30-inch sheaves mounted on 2 $\frac{1}{2}$ -inch shafts, spaced 33 inches on centers. The wire rope of $\frac{1}{2}$ -inch diameter is led from engine, underneath trestle, between these sheaves and attached to larry, as shown in Fig. 2. The larry is operated by a pair of engines

larry by force of its momentum is carried over the "knuckles," the brake on the engine then regulates its speed to the loading terminal. The entire battery is connected to engine room by electric signals. It is possible with this arrangement to charge 100 ovens in 12 hours.

The washed coal when delivered at ovens contains 8 per cent. of moisture. 9,143 pounds of coal is charged for a 48-hour burning, and 14,000 pounds for a 72-hour burning; the latter levels to a height of 22 inches in the oven and it requires 10 minutes to level this charge properly. The coke is "watered out" in the oven by means of a sprinkler, Fig. 3. This sprinkler is so designed that no water can play on the crown of oven. After a series of tests, with respect to oven as designed, I arrived at this result: ash 3 per cent., total coke 63.9 per cent.

Taking the proximate analysis of Durham coal and assuming that the fixed carbon, ash, and 60 per cent. of the sulphur make coke, we get a theoretic coke of 83 per cent.

Analysis of Durham coke, by J. Bladget Britton & Co., Warrenton, Va., is given as follows:

Moisture	0.240
Volatile matter	0.301
Fixed carbon	94.636
Ash	4.823
	100.000
Sulphur (Included in the above)	.651

For sake of comparison I give below the analysis of two other favored cokes.

	Pocahontas Flat Top.	Cornucopia.
Moisture	0.196	0.060
Volatile matter	0.494	0.427
Fixed carbon	93.625	84.962
Sulphur	0.677	0.810
Ash	5.004	9.741

The two chief essential physical requirements of the Durham

coke, hardness of body and well developed cell structure, make it an admirable foundry coke. There is no material difference, other than strength between the 48- and 72-hour coke. The percentage of cell structure, by volume, appears the same in the coke of different burnings.

The water works consist of a Worthington duplex pump—taking water from a well and pumping it through a 4-inch main to a stand pipe 40 feet high by 12 feet in diameter. The pressure at ovens is about 30 pounds.

MINES OF VELARDENA, MEXICO.

A History and Description of Some Little Known but Productive Mines Which Have Been Worked for Centuries.

Written for MINES AND MINERALS, by Ernest E. Payne.

The great lead carbonate mines of Velardena are little known outside of their immediate locality, the company operating them has rather turned the cold shoulder to outsiders, consequently the Velardena Mining & Smelting Co. own or control mostly all the large known veins and deposits in the district. Yet there is some free ground, and were the Velardena district in the United States, it would not be too much to say, that it would be overrun with prospectors.

Location.—Torreon, Mexico, is the junction of the International and Central Railroad. From there the International runs to Durango; in fact, the International is the direct line from Eagle Pass to Durango. Velardena is on the branch between Torreon and Durango. From Torreon, a ride of a few hours over a diversified country, through the fertile valley of the Nazas, takes one into the chaparral-covered deserts; low ridges of limestone rise on either side of the line, with now and then a porphyry cap on small hills, which would suggest probabilities for minerals. Over the big loop, rivaling the famous horseshoe curve in Pennsylvania, we reach the station of Pedricena, from which a branch freight line leads to Velardena, some six miles up the valley.

A mule car is here waiting for such fortunates as are supposed to come for business with the Velardena Company. Some two miles from the station we come to the ranch of Pedricena, where is the district church, where all good Catholics from Velardena and surrounding ranches journey every Sunday morning to mass. As we near Velardena we see that we are in a long narrow valley; on the north side rise the San Lorenzo Mountains, and on the right the small isolated group of mountains called the "Sierra de Santa Maria," where limestone and porphyry are the predominating rocks.

Just before reaching Velardena we pass the "Cerro de Chihuahua," a singular looking mass of porphyry, under which are found scattered, bunches of carbonates. On the other side of this hill we come to shaft No. 5 of the Velardena Mining & Smelting Co.

Along the foot of the Santa Maria lie the deposits, running more or less east and west, and they occur practically all along the foot of the hills, possibly some three miles. Country rock is lime, with occasional bunches of porphyry showing up through the range. A singular fact is that no other mines of any permanency are found in these hills. Occasional peaks are capped with

silicious iron caps, and they have been so far diligently prospected without success.

The Velardena Company operate five shafts on these deposits. Reliable information cannot be obtained as to value of these ores, as the whole concern is under sale to an English syndicate. The values, however, are not high, the abundance of the ore is the factor. The ore occurs in great "salons," as they are called by the Mexicans, twenty to forty feet wide, and of varying length. The deepest workings have penetrated into the sulphides. The mines are worked by a system of pillars, taking out good ore and leaving poor ore as pillars. The water is very heavy. The output of the mines is about 250 tons a day.

The Smelter.—Close by the mines is the smelter, where they are converting 250 tons daily into base bullion, which is shipped and refined in Omaha. They have also a matte smelter in which they are smelting copper ores from a large copper deposit in San Lorenzo, and from which they are turning out a matte containing 50 per cent. copper, smelting approximately 10 tons to 1.

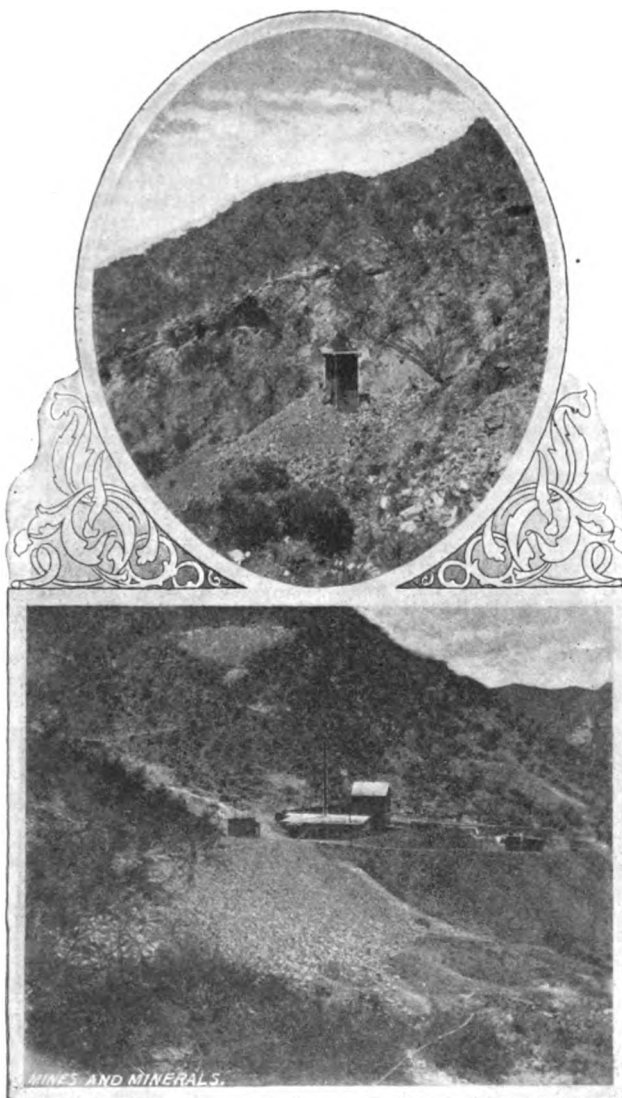
Lime for the smelter is secured close at hand; iron, however, is brought from the celebrated iron mountain in Durango. Silica is secured from their silicious mines in the San Lorenzo, the Terneros mine yielding much silicious ore.

The company has one of the finest installations of machinery in Mexico. The larger part of their engines, pumps, etc., are now run by compressed air, supplied from a central station. The town and smelter are lighted by electricity. Strange to say, this company, with all its surplus power, has never done any prospecting with the diamond drill, preferring the slower and more costly method of shafting to search for ore bodies.

The town contains about 3,000 people. Probably there are seventy-five white employees in the works. The efficient general manager of this concern is Don Carlos Wilhelmi, Don Mateo Dahlgren, the mining superintendent, Don Guillermo Daly, the smelter superintendent.

Wages for miners in this camp range from seventy-five cents to \$1.50 Mexican per eight hour day. Laborers seventy-five cents Mexican. The company runs several stores; men are paid partially in cash and partly in checks on stores.

Mines in San Lorenzo Mountains.—The mines in the San Lorenzo Mountains were opened up by the early Spaniards about the same time as the Avino district and Pachuca district, somewhere between 1650 and 1700. The Terneros, Chona, Coronillos, Quartos, Roca, and Hileta mines were all opened about the same time. The Roca mine was abandoned by the Spanish at the time of the war of Independence, and it lay idle until it was acquired by Francisco Rao Patra, a Mexican who came into this district about twenty-five years ago, and established a native smelter at Carlena, where he smelted ores brought him by "busconies" or prospectors. When his smelter was purchased by the new Velardena Company to prevent him running his plant on ore stolen from their mines, he turned his attention to mining, and acquired by denouncement, the Los Bancos, Santa Juana, Negrita, and Roca mines, and did a little work on them all in the Mexican fashion, working out little bunches of ore and throwing waste behind him, he soon found himself faced with a problem of cleaning out his mines or abandoning them. About this time he sold the Santa Juana, Los Bancos, and Negrita to J. Ernest Mining Co., the Hileta to William Godfrey, and later the Roca to Mr. Charles Von] Brandis, the present owner, all of whom



ROCA SHAFT AND WORKS, SAN LORENZO MOUNTAINS.

started systematic work on their mines, with the result that today these mines are paying handsomely. Within two years of the purchase of the Roca, the little mine had paid for itself, and with depth its ore values have increased in richness.

The Roca mine is developed by a vertical shaft 350 feet deep with levels at 130 feet, 202 feet, 260 feet, and 320 feet. Levels are all about 120 meters in length, connected every thirty meters by winzes. Sinking is carried on all the time and ore reserves are always kept two years ahead. The ore is a sulphide, averaging by carload lots, 200 ounces silver, 15 grams gold, 15 per cent. lead, 3 per cent. copper, excess silica, zinc, and some lime.

Strange to say, zincblende (sphalerite) carries high silver values. The prevailing ore, however, is tetrahedrite. The vein averages 4½ inches wide and is a true fissure vein running N. E. and S. W., cutting through diorite and garnet rock. The heaviest mineralization is on the walls of the fissure, the vein carrying in the center a thin ribbon of silicious gangue showing how the minerals had crystalized out of the heated waters which had filled the fissure.

The Roca is surrounded by producing mines of the Velardena company and the J. Ernest Company. To the south may be seen the old open cut on the Chona, Coronillos and Ternereros from which twenty-two millions were taken by the old "conquestores." Further south is the little Hileta, a gold producer, to the south of that the old San Mateo, and the Ternereros, now developed by tunnel, thoroughly equipped with air drills and compressors, and which is now producing 100 tons of silicious ore daily of an average value per ton of \$50 Mexican.

Parallel to the Roca runs another small vein, called the Negrita, which is just being opened up. It is in the same location as the Roca. The ore was struck at 150 feet about four inches wide, a very silicious ore carrying copper in form of chrysocolla, value 700 oz. per ton silver, 16 per cent. copper, 8 grains gold. This prospecting shaft is on the west end of the Roca claim and shows a peculiar condition of limestone, which has had the lime partly replaced by silica.

The Roca and Negrita mines are equipped with two-horse common-sense whims, as are most all the mountain mines. The mines in San Lorenzo are all dry. Coal is expensive and water costs about two and one-half cents per gallon delivered at the mines.

During the six years that the Roca has been under the ownership of Mr. Von Brandis, it has produced over \$300,000 Mexican.

LEGAL DECISIONS ON MINING QUESTIONS.

Evidence in Action to Quiet Title.—Where plaintiff in an action to quiet title to mineral land claimed exclusive adverse possession from the date of his location, and the evidence showed that defendant had purchased an interest from prior locators, and had continued in possession with them until they leased it to a third party for a term of years, which expired after plaintiff's entry, the lease was competent evidence to show that defendant was in possession by his lessee when plaintiff was claiming exclusive possession. — *Simmons v. McCarthy*, 60 Pac. Rep. (Cal.) 1037.

Mining Claim Located Across the Vein.—Under the rule that where a lode mining claim is located across, instead of along, the vein, the original side lines become end lines, and the end lines side lines, the owner is entitled to all the rights with reference to the new side lines that he would have had if they had originally been located as such, including the right to follow the dip of a vein having its apex within the surface boundaries of his claim beyond the vertical plane passing through such lines. — *Empire Milling & Mining Co. v. Tombstone Mill & Mining Co.*, 100 Fed. Rep. (U. S.) 910.

Foreign Corporation.—A single contract made by a corporation owning mining ground in a territory, by which it employs and agrees to pay a second party to exploit and develop the property, does not constitute a carrying on of business in the territory by the corporation, within the meaning of a statute requiring foreign corporations carrying on business within the territory to file copies of their articles of incorporation, and providing that every act done by them prior to the filing thereof shall be void; and such statute does not effect the validity of the contract. — *Empire Milling & Mining Co. v. Tombstone Mill & Mining Co.*, 100 Fed. Rep. (U. S.) 910.

Optional Contract.—The owner of land granted to another the oil, gas, and other minerals underlying the land, on condition that the grantor should have a certain share of the oil, gas, and minerals so mined. The grant provided that, if no well was completed by the grantee within 90 days from and after the date of the grant, the same should be null and void, unless the grantee should pay the grantor a certain rental for each year the completion of the well was delayed. It was further stipulated that

the grantee should have the privilege of surrendering the lease at any time by paying the rental on the land to the time of surrender. *Held*, since it was optional with the grantee as to whether or not anything should ever be done by him, and as no well was made, there was no obligation to pay any rent, or to make compensation for oil or gas. — *Brooks v. Kunkle et al.*, 57 N. E. Rep. (Ind.) 260.

Contributory Negligence Not a Defense.—When an employee of a mine, endeavoring to alight from the cage at the surface opening of a shaft, fell into the shaft and was killed, the opening of the shaft being enveloped in darkness by reason of no sufficient light being furnished, as required by Hurd's Rev. St. 1889, c. 93, § 6, contributory negligence of deceased could be no defence to the mine owner in an action for damages for deceased's death, under chapter 93, § 14, providing that any injury from failure to comply with the provisions of the act shall give a cause of action. — *Odin Coal Co. v. Denman*, 57 N. E. Rep. (Ill.) 192.

When Accounts Began to Run.—Where plaintiff sold mining supplies to defendant from time to time, and monthly bills were rendered therefor, and interest charged thereon, with the understanding that defendant was to be carried till he could make payment by shipping ore, such purchase did not constitute a continuing running account, but each was made under a separate contract, payment for which was due at the end of the month, from which time the 90 days required by Code Civ. Proc. § 2131, for filing of a statement of lien began to run. — *A. M. Holler Hardware Co. v. Ontario Min. Co. et al.*, 61 Pac. Rep. (Mont.) 3.

Option to Purchase.—A contract by plaintiff to sell, and by defendant's predecessors in interest to buy, certain mining property, which contract is personal, and does not, in terms, run to heirs and assigns, and under which the prospective grantees, although given possession, could neither sell nor assign, without grantor's consent, until they had become entitled to a deed by performance of certain conditions, one of which was to pay grantor a certain sum out of the property, is a mere option to purchase, with a license to extract ore, and not a covenant running with the land. — *Smith v. Jones et al.*, 60 Pac. Rep. (Utah.) 1104.

Additional Certificate of Location.—Gen. St. § 2400, allows the filing of an additional certificate of the location of a mining claim where the locator apprehends that his original certificate is defective, or he desires to change his surface boundaries, or take in part of an abandoned claim. *Held*, that where an original certificate sufficiently located a discovery shaft, and an additional certificate gave a description by metes and bounds starting with the discovery shaft, and running to posts in a mound of stone, the claim could be identified with certainty from both certificates taken together, and hence such certificates were admissible to establish the locator's claim, though neither taken alone, sufficiently described such claim. — *Duncan v. Fulton et al.*, 61 Pac. Rep. (Col.) 244.

Working Property of Another.—Defendant, the owner of a mine, contracted with plaintiff, which owned an adjoining claim, to extend its workings into such claim, for a stipulated price, for the purpose of exploiting and developing the property, and agreed that, should any marketable ore be taken therefrom in the course of such development, it would sell the same, and account to plaintiff for the proceeds. *Held*, that defendant was not stopped by such contract from claiming the proceeds of ore so removed and sold as its own, where, in making the development, it discovered that the vein from which it took such ore had its apex within the lines of its own claim, and the ore was, therefore, its own property. — *Empire Milling & Mining Co. v. Tombstone Mill & Mining Co.*, 100 Fed. Rep. (U. S.) 910.

Was Tipple House the Top of the Shaft.—Hurd's Rev. St. 1889, c. 93, § 6, provides that a sufficient light shall be furnished at the top of every shaft of a mine to insure the safety of persons getting on or off the cage; and section 8 requires that the top of every shaft shall be securely fenced by gates properly protecting such shaft; and section 14 provides that any injury arising from failure to comply with the provisions of the act shall give a cause of action. *Held*, that where a mine owner had erected above the opening of a shaft an uninclosed framework of timber, supporting a structure called a "tipple house," to which the cage could be hoisted, and through which the day shift entered and left the shaft, but it was customary to let off the night shift at the surface of the ground, and plaintiff's intestate being one of the night shift, and endeavoring to alight, fell into the shaft and was killed (it being dark at the surface, and their being no fence there), it was proper to submit to the jury the questions whether the surface or the tipple house was the top of the shaft, within the meaning of section 8, whether the proximate cause of the injury was the absence of a light. — *Odin Coal Co. v. Denman*, 57 N. E. Rep. (Ill.) 192.

ACCIDENTS IN COAL MINES.

Comparison Between the Coal Production and Number of Accidents and Their Causes in Different States and Countries.

By Thomas K. Adams, Mine Inspector.*

Accidents in coal mines is a subject demanding our thoughtful and most serious consideration; in fact, it is a problem which merits the putting forth of the best efforts of every member of this society for its solution. Some of the important phases of this question have been discussed in some of the former meetings of this Institute; many able papers have been written by expert and practical men upon it, and State Mine Inspectors have treated very voluminously in their official reports, on this topic; therefore, in view of these facts, little that is new can be added by us to the information you already possess relative thereto. However, if we can do nothing better we can repeat the same old story, and by its repetition we, with the others, hope to so impress its teaching upon the minds of all persons employed in and about the mines that they will instinctively obey its well intended admonitions.

The life of any man (unless he be a tramp or a criminal) is worth saving. It is vastly more valuable than coal stocks, common or preferred, or any other earthly treasure; hence, nothing should stand in the way which would militate against its preservation. Not even the greed or selfishness of some men nor the imbecility, ignorance, foolishness, and thoughtlessness of others should be tolerated to act as a hindrance in the saving of human life. The premature death of any industrial worker is always sure to bring adverse and depressive social conditions, especially upon those who are his dependents, likewise upon the community where the accident happened, as well as being a direct loss to the State.

Those calamitous disasters which startle us so frequently, sweeping away, instantaneously, valuable lives by the tens and even by the hundreds, are having a dreadful effect, and in fact the finer sensibilities of the public generally have become shocked or almost paralyzed at their frequency, while those who have been in any way culpable for the sad events have become conscience stricken. During such distressing events we have, as usual, a plenteous crop of apologists and general utility men who appear upon the surface at such times as numerously as the 17-year locusts, bringing panacean healing for all our ills. Those men are very resourceful in offering all kinds of excuses for those who are possibly responsible for such calamities. They will tell us about the subtle agencies in operation in nature's storehouse, the mysteries which wiser men than Solomon cannot unravel, and that those mine explosions are the unavoidable and natural accompaniments which gives harmony to the coal-mining industry. Such rot has no weight with intelligent mining men, of course, but dupes there be everywhere. However much these alarming mine explosions may shock the people generally and cause distress in so many homes simultaneously, yet the blighting social effects caused by such incidents sink into insignificance when we compare the number of deaths resulting therefrom, with the number of fatalities resulting from other causes which happen one by one and in such a manner as to escape public notice or compassion.

We may be pardoned for digressing somewhat from our theme in order to give you an idea of the wonderful advancement which has been attained in the bituminous coal-mining industry of this State. We do this merely for the purpose of showing the progress made along certain lines in the mining of coal, and which has not been secured in others. In the last twenty years we have made marvelous progress in material development. In the year 1880 the coal production in the bituminous mines of Pennsylvania was 17,169,448 tons, with 32,694 persons employed in and about the mines, and the production power per employe in coal during that year was 525 tons; while in the year 1899 there were produced 72,866,943 tons of coal and 91,442 persons were employed, and each person having a production power of 797 tons of coal, which shows an increase in tonnage of 400 per cent., in number of persons employed of 300 per cent., and in production power per employe of 52 per cent. Also in the sanitary arrangements and conditions of the mines we are pleased to state that a corresponding progress has taken place, but we are sorry to state that no apparent betterment in the saving of life has as yet been secured.

In the last 20 years in the bituminous coal mines of Pennsylvania, there were 2,509 persons killed, and the amount of coal produced from the said mines for the same period was 967,777,435 tons, or one death to every 385,698 tons of coal produced. The following classification of accidents for the last 10 years in the

mines of the bituminous regions is here given. We find for this period 1,709 persons lost their lives resulting from four general causes, namely:

Causes.	No. of Deaths.	Percentages.
Falls of coal, slate, roof rock, and sides.....	1,082	63.32
Explosion of gas, etc.	213	12.46
Mine cars	258	14.8
Miscellaneous	161	9.42
Totals	1,709	100.00

There were 3,871 persons injured in the bituminous mines of Pennsylvania during the last 10 years. These non-fatal accidents are classified as follows:

Causes.	No. of Injured Persons.	Percentages.
Falls of coal, slate, roof rock, and sides.....	2,229	57.58
Explosions of gas, etc.	131	3.38
Mine cars	975	25.16
Miscellaneous	536	13.88
Totals	3,871	100.00

These statistics show that the number of deaths and injured persons resulting from mine explosions, etc. is very small when compared with the aggregate number of lives lost and persons injured. The average age of the persons killed, taking the number of lives (462) lost in the years 1890, 1895, and 1899 as a basis with which to obtain the average, is about 32½ years.

We desire now to give some comparative statistics, so as to measure ourselves, relative to the saving of life, by the standards attained along the same line in some of our sister States and in Great Britain. In Great Britain, in 1889, one life was lost for every 178,227 tons of coal produced and for every 530 persons employed, and the average tonnage per fatality for the three years 1896, 1897, and 1898 was 207,605, and the average number of persons employed for the two years, 1896 and 1897, per death was 705.5, thus showing a decrease in the number of deaths, when compared with the coal production and number of employees employed for these two periods, of 16.5 per cent. in the former and 32.5 per cent. in the latter.

Illinois.—In 1889 the number of tons of coal produced per life lost was 333,745, and the number of employees employed per death was 716. The average coal tonnage for the years 1896, 1897, and 1898 per fatality was 265,290, and the average number of employees for the said period was 446, showing an increase in the former of 20 per cent., and in the latter 37.6 per cent.

Ohio.—In 1889 there were 330,527 tons of coal produced per life lost, and 615 persons employed. The average number of tons of coal produced per fatal accident for the years 1896, 1897, and 1898 was 298,875, and the average number of persons employed per death for these years was 659, thus showing an increase in the former of 9.5 and a decrease in the latter of 7.1 per cent.

West Virginia.—The tons of coal produced per life lost in 1890 was 206,358, and the number of persons employed per death was 327. The average tonnage per fatal accident for the years 1896 and 1897 was 207,366, and the average number of persons employed for the same years was 359, showing a decrease in the former of ½ per cent., and in the latter 9.8 per cent.

Pennsylvania.—The tons of coal produced per death in the year 1889 was 329,766, and the number of persons employed per life lost 529.5. The average tonnage per death for the years 1896, 1897, and 1898 was 323,760, and the average number of employees for the same period was 490.7, showing an increase in the former of 1.8 per cent., and in the latter, for the same period, of 7.3 per cent.

For the sake of easy reference the above results are repeated in tabular form.

State or Country.	Production per Life Lost in 1889.	Production per Life Lost During 1896-97-98.	Increase or Decrease Per Cent.	Number of Employees per Life Lost. 1889.	Number of Employees per Life Lost. 1896-97-98.	Increase or Decrease Per Cent.
Illinois	333,745	265,290	+20	716	446	+27.6
Ohio	330,527	298,875	+9.5	615	659	-7.1
West Virginia ..	206,358*	207,366†	-.5	327*	359†	-9.8
Pennsylvania ..	329,766	323,760	+1.8	529	490	+7.3
Great Britain ..	178,227	207,605	-16.5	530	705†	-32.5

* Read before the Western Pennsylvania Central Mining Institute, June 29, 1900.

* For 1890. † For 1896 and 1897.

Comparative Results.—Pennsylvania shows a betterment over Great Britain in tonnage per death of 55.8 per cent., over Illinois of 22.2 per cent., over Ohio of 8.3 per cent., and over West Virginia of 59 per cent.; but with the number of employes Great Britain shows a betterment over Pennsylvania of 43.6 per cent. Ohio is better than Pennsylvania 34.2 per cent. Illinois is worse than Pennsylvania in this respect by 9.6 per cent., and West Virginia is worse by 36.6 per cent. But if we compare the statistics of Ohio with those for the mines in the Third, Fourth, Sixth, Eighth, and Tenth bituminous districts of Pennsylvania, where almost similar conditions prevail in the mines of these two places, we find the following comparison for the years 1896, 1897, and 1898: The average tonnage for these years in Pennsylvania was 436,843 per life lost, thus showing a betterment in Pennsylvania's favor over Ohio of 61.5 per cent. in tonnage, and in persons employed of 25.2 per cent.

From the annual report of the chief of the Bureau of Mines of Pennsylvania for the year 1898, the number of deaths by nationalities (which we change to percentages) is given as follows: Americans, 25.63 per cent.; English, 12.56 per cent.; Germans, 4.52 per cent.; Irish, 4.52 per cent.; Scotch, 3.52 per cent.; Swede, 5.3 per cent.; Welsh, 1 per cent.; Austrians, 6.7 per cent.; Hungarians, 5.52 per cent.; Italians, 8.3 per cent.; Polish, 8.54 per cent.; Russians, 1 per cent.; Slavish, 14.6 per cent. Classifying Americans, English, Irish, Scotch, Germans, Swedes, and Welsh as English-speaking people, or who understand the English language, their percentage of fatalities is 56.78 per cent., and the Austrians, Hungarians, Italians, Polish, Russians, and Slavish as the non-English-speaking people, they represent 43.22 per cent. of the total fatal accidents. The ratio which the English-speaking people bear to the non-English-speaking people of the total number of employes employed in the bituminous regions of Pennsylvania we have no accurate statistics at hand to determine.

In the same Pennsylvania Bureau report it is stated that 41 per cent. of all the fatal accidents, and 43 per cent. of all the non-fatal casualties, are attributed to carelessness or violations of the mining laws by the victims themselves.

Now, what do these statistics reveal? They certainly show no reduction in the number of fatal accidents during the last 20 years. Then this pertinent question arises: has a point been reached in the mining of coal when no improvement can be had in the saving of life? To affirm this proposition would be a reproach upon every intelligent mining man of this State. We have not reached our ideal along this line by any means. We are decidedly of the opinion that there is an excessive sacrifice of human life going on in the mines of this Commonwealth; hence, the causes leading thereto must be discovered, responsibilities fixed, and the remedies must be vigorously and effectively applied. We are thoroughly convinced that at least 50 per cent. of all the accidents in the mines can be avoided if the people (mine operators, mine officials, and miners) connected with the mining operations so will it.

We are told that the reasons why progress in the saving of life is not apparent is because there have arisen new and more dangerous causes in the mines during the last 10 or 20 years which were not present prior to that time, such as: the mines are more extensive in old abandoned and live workings, with all their attendant evils; coal is taken from greater depths and from greater distances under the hills, thereby liberating more explosive gas into the mines than formerly; 902 mining machines are now in use with their power to produce dust and noise, and bringing a train of other adverse conditions into the mines; haulage machinery running trains of coal at high speed; electricity at 250 to 400 volts conducted through bare wires dangling about the ears of employes on haulage roads and travelingway claiming its victims; motors of all kinds doing work, adding dangers and confusion in the mines, which were not present 20 years ago; men have been introduced into the mines by the hundreds and thousands for the purpose of mining coal who are nearly as ignorant about mining methods, and the putting into practice the proper safeguards for the protection of their own lives, as the animals that haul the coal from them, and discipline has become so lax that nearly every workman has so imbibed the spirit of liberty that he has become a law unto himself. These things are the outgrowth of the spirit of the times.

What are the essential remedies to be applied to cope with the present condition of things? We would suggest the following: First, to prevent mine explosions we must remove the causes. This can be done by having strong currents of air traversing all the live and abandoned workings of the mines, where practicable, by the method of divisional ventilation. Accumulations of gas in waste workings must be removed or prevented by the methods of boring holes to them where they would be of practical utility. All portions of the mines to be constantly under the supervision or oversight and inspection of firebosses, with properly arranged divisions of not larger extent than can be conveniently inspected

frequently during the daytime as well as in the morning; as now required by law. Dust must be removed from the mine or thoroughly dampened in the immediate vicinity of shot firing. The firing of shots where gas is being produced, or where dust may be present, should be done by careful and competent miners, or done under the oversight of prudent and practical men. Also flameless explosives should be used. Men should not be put into the mines where firedamp exists, nor safety lamps put into their hands, unless they are competent to use them properly and understandingly, and are capable of receiving instructions from the person having the oversight of the division of the workings where they labor. Both the spirit and the letter of the present law, regulating this matter, should be rigidly obeyed. Firedamp and coal dust are not the miner's most dangerous foe, for only 12.46 per cent. of all the fatal accidents result from explosions, and in the mines where prudent, conscientious, and thoughtful men are in control of them, together with a liberal but not wasteful expenditure of money to put into force all necessary safeguards, mine explosions will be few indeed, if not entirely eliminated.

Sixty-three and thirty-two hundredths (63.32) per cent. of all the fatal accidents in the mines are due to falls of coal, slate, roof rock, and sides. We are decidedly of the opinion that the securing of the roof, slate, etc., should be done by specialists, or men employed specially for such a purpose. Very few miners are expert timber men, and when they do set posts they are seldom set properly, and they are put up without the apparent exercise of good judgment. They do this kind of work in a haphazard manner, and the time given to securing their working places is given grudgingly, and such work is usually put off to a more convenient season. There should be one man employed to timber, or at least have the work done under his supervision, so many rooms, according to the nature of the roof and the amount of timber to be used. This man should have a general oversight of all the working places in his division, and be held responsible for their safety. He should see that each miner is supplied with the requisite amount of timber.

Mine cars are another fruitful source of accidents, and 14.8 per cent. of them are due to this cause. Mine cars should be carefully inspected (in the same manner as railroad cars are inspected), and if found defective they should not be allowed in the mines until they are repaired. Haulage-road beds should be kept free from water, a good weight of T iron rails and plenty of good ties should be provided and all kept in a solid condition. Brakes should be used on all cars instead of spragging the wheels, and all trips of cars be kept under perfect control. Drivers should ride on rear end of trips instead of the front end or between the cars, and all haulage roads should be of ample size and kept clean. Dilly trips, or trips by any other method of haulage when men are required to ride upon them, should not be run at a higher rate of speed than about five miles per hour. The rope rider or motor driver should have exclusive control of the running of all trips of cars, and should he know of any unauthorized person being on them, he should immediately stop them and put him off and report the same to the proper authorities. There are 9.42 per cent. of the accidents due to miscellaneous causes, such as electric wires, mining machines, and machinery in general, careless handling of explosives, premature blasts, men falling down shafts, caught under hoisting cages, by mules, etc. No electric wires should be allowed on any travelingway where a high voltage is required, neither should any electric motor be allowed where men are required to travel, and in the workings where firedamp is being produced, electricity in any form should be prohibited. If electric wires should be used they should be conducted through separate passageways provided exclusively for their use, and when they have to cross over haulage roads a groove of sufficient depth should be cut in the roof and the wires properly cased with insulating material. Nearly all the other causes under this head are well provided against by the mining laws, except mining machines.

Mining machines are claimed to have added considerably to the death rate at many of the mines, and owing to this idea prevailing among so many men their exclusion from the mines has been advocated. The remedy, in our opinion, does not lie in this direction, but limitations should be put upon the use of certain types of machines under certain conditions. If the mine roof or slate will not admit of the use of machines with safety, they ought to be excluded from such mines; but we are convinced (except in some very exceptional cases) that all types of machines can be used with a reasonable degree of safety where firedamp is not present. In order to accomplish this, however, a very radical change in methods must be effected. The very harmful parsimony so evident under present methods of operation must be eliminated. More time must be allowed to do the work and a safer system of timbering must be adopted, which can be done both safely and economically.

Another of the great causes in maintaining the high death rate in the bituminous mines of Pennsylvania is the employing of so many men to mine coal who are utterly incapable either by intelligence, experience, or training to protect themselves against the danger incident to mining. Too many of the non-English-speaking people are like sheep led to the slaughter. They are so ignorant of mining methods and the dangers incident thereto and of the use of the necessary safeguards for the protection of their lives that the great wonder to us is that more of them are not killed. They are employed by the hundreds to go into the mines to labor at all kinds of work without question, by those who employ them, as to their previous service in the mines or their ability to take reasonable care of their lives. A large number of such people know practically nothing about the proper use of the safety lamp and much less about firedamp and its dangers. They practically know nothing about how, where, and when to use timbers in their working places. Even their attention is not called to the mine rules, and all lawful requirements are like a sealed book to them. Owing to the mine foreman's inability to converse with this class of laborers in their own language, they cannot have the benefit of his instruction when he makes his visit to their working places for that special purpose. Under such conditions those people should not be employed in such large numbers, and when employed, their employers should be held responsible for their safety. When employed they should only work when under the constant supervision of some competent or trustworthy person until, at least, they are instructed in the proper use of known safeguards and in the methods used in detecting dangers. This suggestion will apply with equal force when Americans are employed to mine coal when they have had no previous experience. The Americans have the highest death rate when the percentages are considered by nationalities, hence the necessity of putting some restraint upon inexperienced men being allowed to work in the mines until they have received proper instructions, etc.

Still another of the supreme causes for the failure to reduce the number of accidents is the utter lack of discipline among the employes in so many of the mines. It seems that the underground mine officials, with, of course, a few honorable exceptions, have evidently no control over the men who are supposed to be under their authority. Everything appears to be running at loose ends. The mine officials must exercise their authority and maintain discipline among the employes at all hazards. When a reasonable order is given by any official it must be enforced by him and implicitly obeyed to whomsoever it is given. Men must be made to respect the law, and all mine operators and officials must set the example by willingly complying with all of its requirements. Mine foremen must not for a moment allow themselves to be intimidated by superiors or inferiors in station, by means used directly or indirectly, in seeing that the letter and even the spirit of the mining laws are faithfully carried into effect, and all lawful duties required of them must be conscientiously performed and done willingly, methodically, and without laxity. Mining laws are enacted for the protection of the workingmen, and any infraction of them by any persons should be visited by a penalty upon the guilty parties. Leniency shown to some men breeds contempt in them for law, hence the violators of it must be punished both speedily and with certainty. If our present machinery to be put into motion in order to have the mining laws enforced is too complex, it must be simplified to meet the demands, and nothing that is reasonable should be left undone that will assist us in reaching our ideal in the saving of human life.

Dawson and the Yukon Territory.

The census of the Yukon Territory, taken last April, shows an increase in the population of Dawson City of nearly one thousand since September, 1899. The population of the whole Yukon district, however, has decreased some two thousand.

There is an ample supply of good water now, pumped from artesian wells and piped to stores and houses at a cost to the buyer of from \$4 to \$5 per month; large restaurants and saloons are charged \$10 to \$15, and hotels \$25.

The town is busy as is usual at this season of the year, and money is plentiful. There is not the disposition prevalent in former years to squander hard-earned money, but the temptations remain the same. There are no places for the miners to go to for innocent recreation, so they naturally flock to the gambling halls, which are made inviting enough. Gambling is not looked upon in this community as a crime, but as a pastime, and it is no uncommon sight to see employer and employee at the same table; lawyers and their clients, bankers, and bank clerks all patronize the tables, and it was only lately that the head of a large trading company lost \$21,000 in a single night. A conservative estimate as to the output of gold for this season, as published in a Dawson newspaper, places the figure at \$18,000,000. There are 5,280 men employed at an average wage of \$1 per hour.—*U.S. Consular Reports.*

THE HAILE GOLD MINES

Of South Carolina.—Some Striking Peculiarities in Regard to the Ore Bodies as Compared with Most Western Deposits.

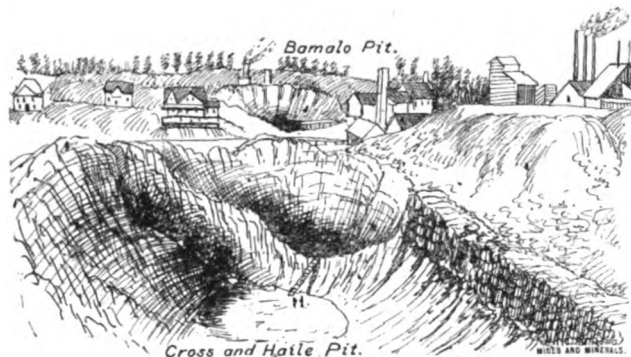
Written for MINES AND MINERALS, by Prof. Arthur Lakes.

In different mining regions we often find very different conditions, both in the character and deposition of ore deposits as well as in the mode of developing them.

No mining region is a hard and fast type or rule for another, nor can any hard and fast rules be laid down for development in different regions. We may have certain general rules laid down in books, but commonly we have to modify and adapt these rules, as well as ourselves, to the circumstances in which we are placed.

Take Colorado; there is a difference in modes of development between the various camps, often but a few miles apart. The fissure veins of Boulder, Clear Creek, and Gilpin counties are developed mostly according to a regular type system of shafts, drifts, and overhead stoping. At Leadville the great chambers of ore deposits require a different system and the use of square sets. Silver Cliff has great open quarries, and deep open cuts like railroad cuts in its ore deposits. Cripple Creek, too, has its variations from the usual rule, as, for instance, in the circular funnel or well-like deposit of the Anna Lee.

When we leave the West and go South to the Southern States, such as Georgia and South Carolina, we find an entirely different condition of ore deposits, and, in consequence, a very different method of development. Here the characteristic feature is that of broad zones, it may be some hundreds of feet in width, composed of narrow lenses and veinlets of low-grade ore disseminated through a zone of schistose or slaty country rock. Such deposits have to be worked wholesale to be worked at profit, consequently,



CROSS AND HAILE PIT.

instead of the regular orthodox shaft and narrow tunnels and drifts, we find huge, open, crater-like pits 200 feet wide, it may be, by a hundred or more feet deep. In the drifts and shafts communicating with these, we find ourselves in vast, open, cave-like chambers from which the great low-grade bodies of ore have been taken, and we look up uneasily into their dark recesses, wondering how the roof keeps up, seeing there is not a stick of timber to support it, for none has so far been found necessary. We observe that the mine is supported mainly by natural pillars, as in a great coal mine; such are the striking features of the celebrated Haile mines we lately visited in South Carolina.

The general geology of this region is as follows: A country composed mainly of clay slates, or alumina-magnesian slates, or perhaps more accurately "siliceous-hydromuscovite and argillaceous slates and schists," having a general strike of from 45° north to 70° east and dipping northwest at an angle of from 55° to 85°. These slates are sometimes graphitic and chloritic; they are intercalated with small lenticular quartz veins, and at times with large quartz veins from 12 to 20 feet wide. The large veins are often barren; the values lie in the small quartz veins and schists, both of which are apt to be impregnated with pyritic gold-bearing ore and with free gold. The general masses constituting the ore bodies are lenticular in shape. The outline of these masses does not conform necessarily with the strike and dip of the slates, but is determined rather by the degree of impregnation. The lenses may be 200 feet in length and 100 feet wide; dipping 50° to 60° northeast, or northwest from 45° to vertical.

The whole series is traversed by diabase dikes, having a general north and south course. These dikes are from 12 to 500 feet in width. In the Haile region there are four notable dikes. One is 500 feet wide, which seems to traverse the entire State. Another, 1,000 feet north of this, is 130 feet wide, and a third, 400 feet from the last, is 12 feet at the surface, and below ground increases to 35 feet. A fourth, 500 feet from this, is 150 feet wide,

and about eight miles north is another group of dikes at the Hegler mines.

The heat of the dikes metamorphosed the slates for 400 feet between dikes, and to a considerable distance on either side. The metamorphic influences are shown in a quartzose condition of the slates; chlorite and graphite occur near the ore bodies. Where these dikes have crossed the ore bodies they have enriched the ore. The ore bodies are evidently connected with the dikes, as they are found on both sides of them as "contact deposits," the dike itself being barren of ore. The ore bodies appear to be zones of alteration and substitution of the slates by quartz and pyritic matter. Thus are formed large deposits having a well defined hanging and foot wall, but liable to fade out with depth and length into barren slate. These bodies are, in the Haile property, from 50 to 90 feet in width, with a length of 200 to 600 feet. The depth is from 180 feet at the shallowest to the deepest, which shows ore bodies to continue down below the lowest depth attained, viz., 350 feet. These ore bodies are found both sides of the dike, their length corresponding very well with their depth. The slates of medium hardness are generally the richest; graphitic lamina are good indications of ore; seams of hornstone sometimes occur. Free gold and sulphurets are mingled. Free gold is found at times deposited on graphite and chlorite, and the best ore shows where the ore is most graphitic, quartzose, and chloritic.

The most values derived from the mine are from pyrite, which is very fine-grained and generally disseminated. It is a bisulphide of iron of a greenish tint. Ore containing coarse sulphurets is generally poor grade. The crucial test of the values of the ore is in the amount of free gold it contains, which is in direct proportion to that contained in the sulphurets, and is determined by daily panning. The ore at present delivered to the mill averages about \$4 per ton, of which value about one-third is free gold. The percentage of sulphurets in the ore varies from 2 to 25 per cent.

History.—The first records of any mining being done are in 1829, when the ore was worked as a sulphur and copperas proposition. In 1832, gold mining and working of placers was conducted on a small scale on the branches of the creek, and remains of old arrastras are found. This placer mining, as is commonly the case, led up to the discovery of the ore in place, or what is now known as the Haile mine. At that time the ore on the mine site was divided up into 50-foot-square claims. There was a broad outcropping of oxidized ore on the surface, in other places a broad zone of sulphurets. This was in old slave days. The zones were worked down in big open pits direct from the surface, as may be seen at the Bumalo pit, with one shaft in that case down 120 feet. The ore from the mine was taken by slaves three miles to numerous arrastras. The first mill was of 5 stamps, followed later by 10 stamps, and in 1881 enlarged to 20 stamps.

About 1884 a Blake dry crushing mill of 225 tons was erected in connection with 20 Embrey tables. This was soon abandoned. From being a dry crusher it failed through loss of time and repairs involved; and ran in consequence only one-third of its proper time.

To treat concentrates by amalgamation and roasting, a Walker furnace was established; this also proved a failure. Experiments were carried on without much success from '84 to '88, till Mr. Thies took hold, who recognized it at once as a low-grade, but large-quantity, property, that could be made to pay by judicious development and a suitable milling process.

Prior to his time the company had erected a 20-stamp mill, saving only the free gold and allowing the sulphurets to go down the creek. Mr. Thies put in eight concentrators behind the 20 stamps. This was followed immediately by a chlorination plant for treatment of sulphides with roasting furnace, and three barrels added gradually.

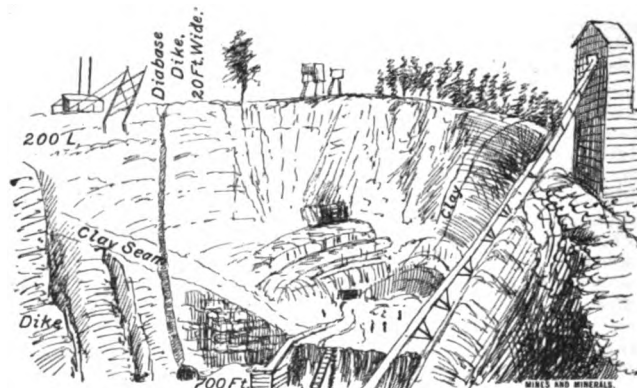
In 1889, the Blake mill was changed to a 60-stamp back-to-back mill with 20 concentrators. Meanwhile the development work of the mine was pushed, consisting of driving drifts and crosscuts from the old shafts to ascertain the extent of the ore bodies. These being found to be very large and of low grade, there followed the question of putting through large quantities of ore to make it a paying proposition. From drifts upraises were made from one level to another, preparing ground for extracting the ore by stoping. Then they tore out the old Blake crusher, preparatory to erecting 40 more stamps, making the present 60-stamp mill.

All work was open cutting until 1880, when underground mining was begun and continued to the present. Although visible coarse gold is now of rare occurrence, the mine has yielded some nuggets worth from \$300 to \$500 from the decomposed slates in the shallow open cuts.

The mines worked at present are the Cross, which is a continuation of the old Haile and Flint pits, and the Beguelin. Red Hill, and Chase Hill pits were not worked for some time, although at the first there was considerable underground work. Work at

the Cross mine was stopped in 1888, and attention concentrated on the Beguelin. The old workings consist of open pits and three perpendicular shafts; one 70 feet deep in ore, one 54 feet deep in the diabase dike, and one 70 feet deep in the foot-wall slates on the southwest side of the dike. The first of these was transformed from a depth of 60 feet downward into an inclined shaft, and sunk in the ore body 195 feet. This shaft was rigged with self-dumping skip crusher, and ore bin, situated over the railroad tracks, which had been extended to the mine. At 60 feet a drift was run north-east until the diabase dike was reached. Meanwhile sinking was continued on the shaft to 120 feet. From this level, drifts were run and connections made with the 60-foot level, which prepared the ground between them for stoping. At 180 feet a similar drift was run to the dike, and connections made with the upper levels in such a manner that the ore from the 60-foot level would fall to the 180-foot level and from there be hoisted to the surface. At 180 feet a drift was started southwest, encountering at 64 feet a dike 125 feet thick, through which the drift was continued to a distance of 600 feet from the shaft. At a depth of 70 feet a similar drift was run and the ore body beyond the dike prepared for stoping by connecting these two drifts by several raises.

Northeast of the shaft a large body was still standing above the 60-foot level. To extract this ore it became necessary to open the mine from the surface and the open pit was started. The ground was stripped to a depth of 15 feet, and from that point the ore was used in the mill. A diabase dike parallel to the schistosity of the country was encountered in crosscutting. On cutting through it a distance of 4 feet it was found to merely divide the ore body. Under these altered conditions a new shaft was sunk in the hanging wall, as an outlet for the ore and for pumping, to a depth of 195 feet. Everything was then prepared for taking out the shaft pillars as well as the balance of the ore. The maximum



THE BEGUELIN PIT MINE, SOUTH CAROLINA.

thickness of the ore body at the Beguelin was 80 feet, and the best ore was found between two large cross-dikes. This mine contains yet large bodies of ore.

A 60-stamp mill was run on Beguelin ores for three years. The Cross mine was then reopened and a drift of 200 feet, made at the bottom of the pits, encountered a dike 25 feet thick, which was cut through and the drift continued for 100 feet more. Four upraises were driven between the two levels one each side of the dike, opening up four large stopes of ore. This ore ran low in sulphurets, but carried more free gold. A new shaft was sunk 270 feet, and a southwest level driven from it found the dike to be 35 feet thick, and no longer decomposed on the wall, as was the case in the upper level. By upraises four more stopes were opened, which furnished ore for the mill.

The ore was of a little better grade in proximity to the dike on both sides. A northeast tunnel 150 feet long in Bumalo pit struck a diabase dike 150 feet thick. The ore was found richest near the dike.

From the 270-foot deep shaft a 600-foot long northeast level opened up large ore bodies in proximity to the 150-foot thick dike, which are connected with the 200-foot level by upraises. The 270-foot shaft was sunk to 370 feet, and from a station at 350 feet a northeast level found the ore to continue below the 350 feet near the dike. Upraises connect this ore with the stopes in 270 feet.

Three different lenses, or great bodies of ore have been found: (1) The Bumalo, farthest northeast. (2) The Haile, or middle lens. (3) A small lens 80 to 90 feet west of the Haile and the Red Hill open pits on northeast side of the 150-foot dike, where ore was formerly mined to a depth of 60 feet. The thickness of these lenses or ore bodies varied, reaching 100 feet in places, in others only 25 to 30 feet.

Mode of Development.—The method of working these large ore bodies is by the pillar system not unlike a great coal mine. The levels 8 ft. $\times$ 7 ft. are run 70 to 100 feet apart and nearer the hanging than the foot wall. At intervals of 50 feet upraises are made with a cross-section 8 ft. $\times$ 7 ft. These are carried forward at 45°. The upper portion through the chain pillar left under each level is carried up vertically. This raise serves afterwards as a chute. Drifts are then run below this pillar until the limit of the slope in length, 30 to 40 feet, is reached, leaving a vertical pillar 15 to 20 feet thick between stopes. The ground is then cut away between the foot and hanging walls, exposing as roof the bottom of the chain pillar, above which it is sprung in the shape of an arch, with its heavier toe on the foot wall at a minimum thickness of 15 feet. This work is all done by air drills. Stopping is then carried downwards by hand drilling in circular steps arranged in such a manner as to allow the ore to drop into the chute on blasting without further handling.

The angle of 45° given to the latter allows a steady flow of the material down the foot wall without completely choking it. At the bottom of the chute is a rough grizzly made of logs holding back the large boulders and preventing them from choking the smaller loading pocket below. This grizzly is easily accessible from the drift, and the larger pieces of ore are here sledged. The loading chute and grizzly are kept up as long as possible until the stope is finally broken through to the drift level below, the ore being shovelled into cars.

Pillars are left in poor ore, if possible, the diabase dike fulfilling this purpose admirably. No timber is used and although chambers 100 ft. $\times$ 100 ft. $\times$ 40 ft. have been cut out, there seems no danger of a fall, the country slate being very tough and self-supporting.

The stopes from the 100- and 200-foot levels are connected with the surface by raises so that at a future date the worked-out stopes can be filled from the surface and the ore in the pillars, that is, what is left toward the hanging wall can be taken out.

Blasting is done with 40 per cent. Hercules powder. One-inch steel is used for hand and 1½-inch for machine work. The number of air drills is limited by the size of the compressor. Driving and raising is done by air drilling, the stopping being done by hand labor. The latest improved Rand drills are used; the one known as the "Little Terror," which has a diameter of 3¼ inches; the air is supplied to these drills by a class C Rand compressor, and an Ingersoll compressor for 10 drills is ready for work when needed.

The ore is carried from the loading chutes to the shaft in wooden cars of ½-ton capacity running on 18-inch gauge track.

At No. 2 shaft (7 ft. $\times$ 12 ft., single compartment) they are hoisted by cage with an automatic safety catch.

The new shaft is 6 ft. $\times$ 14 ft., triple compartment, and the ore is raised by a novel skip designed by Mr. Thies. The body of the skip, made of sheet iron, has two projecting lugs riveted to it below the center of gravity, and the bail is lugged 1 inch from the vertical center line. Each lug runs between a pair of yellow-pine guides set 2 inches apart; when the skip is raised above the landing chute, two iron pins are thrown across the opening between each set of guides. The skip is dropped down on these and the ore is dumped into a loading chute placed on the heavier side of the skip.

The skip is raised and righted by the bail, the iron pins are withdrawn by the top man, and the skip descends.

The operation is rapid and simple, and the cost of the device is light.

The mine is not wet, a No. 9 Cameron pump easily handling all the water. For the details of this account, apart from my own observations, I am indebted to Mr. Thies, as also to the very minute and accurate description, by Messrs. Nitze and Wilkins, in the transactions of American Institute of Mining Engineers, October meeting, 1895.

Coal in India.

Coal is widely distributed throughout India, except in Bombay and Sind, the Northwest provinces, and Oudh, Rajputana and Mysore, where the mineral is either scantily distributed or entirely absent. The seams in Bengal and Assam are frequently from 50 feet and 80 feet to as much as 180 feet in thickness. The pits are often of considerable depth. At present the deepest appears to be about 700 feet. In many cases the working of the seams leads to the escape of little or no firedamp, so that the miners are able to work with naked lights. At the present time Bengal produces more than three-fourths or the coal mined in India. Indian coal varies much in composition and quality. Most of it is quite suitable for ordinary purposes, while some of the samples, e. g., certain of these from Bengal and Central India, are of excellent quality, equal to that of some of the best British

coals. The fixed carbon of the Bengal coal ranges between 50 and 60 per cent., and the calorific value exceeds 6,000 calories—equal to about 10 British thermal units—while the ash often does not much exceed and in some instances falls below 10 per cent., and the sulphur is frequently present in but very small proportion. —*Science and Art of Mining.*

Idaho—A Glance Backward.

Extract from the Report of J. A. Cizek, Inspector of Mines for 1899.

From the date of the first discovery of the precious metals in Idaho in the early sixties to the present, this State has taken and holds an enviable position among the mining States of the West. True, Colorado and Montana seem to have forged ahead more rapidly, owing to the fact that these States for some reason seem to command all the necessary capital to develop the rich mines there, while Idaho, though wonderfully rich in all kinds of natural resources, especially in gold, silver, copper, and lead, did not attract the attention of men of capital until a comparatively recent date, but now that her wonderful properties are becoming known in the centers of the world's commerce, Idaho is rapidly taking the lead.

It may be truly said, without boasting, and preserving conservative limits, that Idaho has a greater wealth of mineral resources than either Colorado or Montana. Her placers have been the wonder of the nation, and are still pouring their millions into the lap of commerce. Her lead mines now produce nearly half of all the lead produced in the United States. Her gold quartz mines have been touched only in places, and her mountains of silver, when justice has been done to the white metal and bi-metallism triumphs, will reveal a wealth as marvellous as that of the Indies.

A conservative estimate of the wealth of gold and silver added to the world from Idaho since the discovery of gold here is in excess of \$250,000,000. Over \$40,000,000 in gold and silver have been turned into the various assay offices of the United States since the organization of the Territory. Since Idaho became a State in 1890, she has produced in gold and silver, saying nothing about lead and copper, \$72,744,575. By years the output of gold and silver, as given in the *Statistical Abstract* issued from the United States Treasury Department, is as follows: 1890, \$6,663,838; 1891, \$6,896,970; 1892, \$6,196,451; 1893, \$6,703,159; 1894, \$6,333,081; 1895, \$5,804,380; 1896, \$8,813,757; 1897, \$8,038,605; 1898, \$8,692,107; 1899 (estimated), \$8,603,028.

The estimate for the year 1899 of the product of gold, silver, lead, and copper is as follows: Gold, \$2,500,000; silver, \$6,103,028; lead, \$4,960,410; copper, \$60,000; or a total of \$13,623,418.

Apart from her large mountains of mineral-bearing quartz, her placers are extensive and valuable. The Snake River bars are rich in flour gold, which modern methods of treatment are now rendering available, and soon this vast wealth of the yellow metal will be poured into the avenues of commerce. With increased transportation facilities and the improved methods of treating the baser ores, the mineral wealth of Idaho will soon be doubled.

In concluding, this report may point out that the exhibit herein made does not do justice to Idaho as a mineral-producing State. The State has been only partially prospected. No State in the Union has more extensive and valuable mineral resources than Idaho. In lead her mines are the greatest in the United States, and when the vast copper properties of the Seven Devils district are developed, as they bid fair to be in the near future, the copper output of Idaho will astonish the world. With the triumph of bi-metallism will come wonderful activity in the rich silver mines of the State; and with even the larger use of silver, the silver output of the State will be astonishingly large. Her gold placers yield large, and her vast gold quartz mines, with modern facilities for working and better transportation facilities, which are sure to come, will double and quadruple the gold product of the State. When the problem of saving the fine flour gold of the Snake River bars has been solved, and these bars are worked, it is impossible to tell how large the gold output of the State will be. The fact is that the output of the precious metals in Idaho is much larger than that given in this report. The report is based on the amount of gold and silver actually accounted for by the United States assay office in Boise, but large quantities of the precious metals are mined here and taken out of the State that are not reported to the assay office at all. There are few smelters in Idaho, and no inconsiderable quantities of gold and silver taken from ores shipped out of the State for smelting are credited to those States where the ore is smelted, and Idaho does not get the credit for them. This State, it seems to me, from a careful examination of the conditions here, is a good point for the establishing of smelters, at least in certain localities. The attention of mining people is respectfully called to this subject.

THE METALLURGY OF ZINC.

The Physical Properties—The Chemical Properties. Zinc Ores—Methods of Reducing the Ores.

The Dry Processes—Wet Processes—Electrometallurgical Process—Processes in Which Zinc is Obtained in the Form of an Oxide or Pigment.

Written for MINES AND MINERALS, by H. Van F. Furman E. M.

(Concluded from August.)

Silesian Process.—This process, which was introduced in the year 1798, is carried out in reverberatory furnaces in which muffles are arranged. The zinc vapors which are distilled from the charge in the muffles are condensed in various forms of adapters. The muffles generally have the form of prismatic boxes with an arched roof, although the roof is sometimes flat and the corners are rounded. The rear end of the muffle is closed, whilst the front end is open. During the distillation the lower half of the front end of the muffle is closed with a fireclay tile, whilst the upper portion is closed by the end of the adapter which is tightly luted on with fireclay. The muffles are generally 26 inches high (inside measurement), 6 to 8 inches wide, and 28 inches to 7 feet long. When the muffles are only supported at their two ends their length should not exceed 4 feet. The walls of the shorter muffles average about 1 inch in thickness, whilst the longer muffles have thicker walls, the bottom frequently being 2 inches thick. The same materials used for the manufacture of retorts in the Belgian process are used for the manufacture of these muffles. They are made either by hand or by machinery, hydraulic machinery being generally adopted in modern works. They must be introduced into the furnace in a red-hot state.

The ordinary Silesian furnace is shown in cross-section in Fig. 4. It is divided into a series of bays on either side of the fireplace, each bay containing two muffles, which rest on the bed, and are consequently heated only on the sides and crown. The ends of the muffles project through the side walls of the furnace into a small outer chamber. The grate is shown at *a*, the muffles at *c*, the adapters at *x*. The adapters are provided with an opening at the bend *d*, which is closed by a plate luted on during the distillation, which serves for the removal of obstructions. The condensed metal flows into the receptacle at *b*. This form of condenser has been largely superseded by other forms which approach those used in the

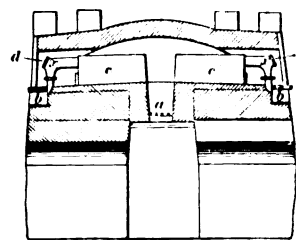


FIG. 4. SILESIA FURNACE.

Belgian process, being provided with nozzles for condensing the fume, thus resulting in a greater saving of zinc.

The operation is much the same as in the Belgian process and lasts 24 hours. In consumption of fuel and labor the process is somewhat more expensive than the Belgian and the loss of zinc is greater. However, with the introduction of furnaces fired by producer gas and provided with regenerator flues, the fuel consumption is not much greater and an inferior quality of fuel can be used. This furnace is only used for the treatment of poor ores, such as the silicate and carbonate ores of the Silesian provinces, where ores containing 20 per cent. of zinc are treated at a profit.

Belgo-Silesian Process.—The furnaces used in this process differ materially from the older forms of Silesian furnace, the flames not being allowed to escape from the furnace, either through the arch or laterally, but being first made to strike the arch and then to return, escaping at the bottom of the furnace. The products of combustion are led into a common flue running under the hearth of the furnace into a stack, or into several stacks. Sometimes before escaping into the stack they are utilized for heating retorts and calcining ores. The supports for the muffles are made as small as possible, so that the bottom shall be partially surrounded by the flames. In the older Silesian furnaces we have a single row or tier of muffles, whilst in the later Belgo-Silesian furnaces we have several tiers (usually three) of smaller muffles, one tier above the other. The furnaces are fired either by grates or by gas, either with or without regenerators.

Before the furnace is placed in active operation it is heated up gradually for three or four days, when the muffles are put in place and annealed in the furnace itself. The firing is now increased for three or four days, when the muffles are bricked in, the adapters are attached, and the muffles are charged. When the

bellied form of adapter is adopted the charging is done through the front of the adapter, whilst with adapters having the form of inclined cylindrical tubes or of rectangular boxes, the front being closed by a tile or clayed iron plate, charging is done through the apertures left when the tile or plate is removed. The temperature must be kept as uniform as possible throughout the operation of distillation, for if it is too high, uncondensed zinc escapes through the adapters and burns when coming in contact with the air; if it is too low, the zinc condenses as fume, which is partially caught in the adapters and is partially carried off by the gases. After the distillation is finished the zinc is removed from the adapters, the residues are raked out, the muffles are repaired or replaced, and a new operation begins. The distillation operation occupies 24 hours. The weight of charge varies from 60 to 200 pounds, according to the size of the muffles.

A recent form of furnace fired by gas but not provided with regenerators is shown in Fig. 5. The gas producers *p* are located at both ends of the furnace, the air for the combustion of the producer gas being preheated in the walls of the furnace as is shown in the illustration. The muffles *c*, the adapters *x*, and the nozzles *y* are shown in the illustration. The gases after passing over and around the muffles pass into the flues *s* and thence to the stack.

Treatment of the By-Products.—The distillation operation being imperfect, a number of by-products containing zinc are produced. These are zinc fume, (blue-powder) flue dust carrying zinc, the residues from the adapters and the retorts, furnace accretions carrying considerable zinc, and the zinciferous skimmings from the refining operation. The zinc fume is finely divided metallic zinc and generally contains about 10 per cent. of zinc oxide and also cadmium, arsenic, antimony, lead, and other substances which are volatilized from the charge during the distillation. It is generally treated with the ore charges in the distillation furnace, being added in small amounts so that its impurities may be distributed through large quantities of zinc. It is treated in those retorts which are subjected to the lower temperatures. Sometimes it is allowed to accumulate, and at intervals a special run is made of this material and other by-products, the result being an impure zinc. The residues from the adapters and the flue dust, which consists largely of zinc oxide, are generally added to the ore charges in the distillation furnace. The residues from the retorts or muffles contain from 4 to 11 per cent. of zinc. They

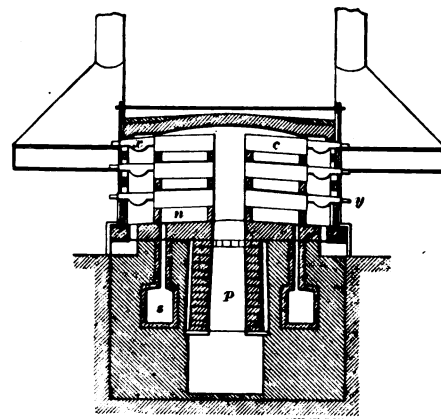


FIG. 5.

are sometimes subjected to a dressing operation, the result being concentrates rich in zinc, which are treated with the ore charges. The refinery skimmings, which are rich in zinc, are treated with the ore charges or are distilled together with the zinc fume and the residues from the adapters for an inferior quality of zinc.

Improvements.—The present distillation methods are crude, wasteful, and expensive. As far as the roasting is concerned, the introduction of mechanical furnaces and means for the condensation and utilization of the sulphur vapors have greatly lessened the expense of this operation. The distillation process, however, continues to present great obstacles to improvement. It is a non-continuous process; each successive charging of the vessels necessitates lowering of fires and cleaning of retorts, resulting in a large consumption of fuel and labor. A large quantity of zinc is lost in the various operations. A quantity of finely divided metal and zinc oxide is produced at each operation, and as this has to again undergo distillation the capacity of the distillation furnaces is materially reduced. Another serious objection is that, with the furnaces now in use, ores containing any considerable admixture of foreign sulphides or oxides cannot be treated. Ores composed largely of blende, with an admixture of iron and copper pyrites, and galena carrying some gold and silver are frequently encountered in our mining regions, and as they occur in enormous deposits, especially in the Western States of America, some method for their economical reduction has been desired. The zinc smelters of the United States will at present not treat ores containing to exceed 2 per cent. of iron and 3 per cent. of lead, as these metals combine with the silica of the retorts, forming fusible slags which rapidly destroy the vessels. Ores containing larger amounts of these metals must be mixed with other ores, so as to

bring the percentages of iron and lead within the above limits. In most instances such mixing is impossible, nor can the ores be successfully smelted for lead bullion on account of their high zinc contents. Experiments made in Denver, Colorado, during the past 18 months have apparently overcome this difficulty. These experiments were made by Prof. Benjamin Sadtler, who has recently protected the principles involved by both domestic and foreign patents. It is through the courtesy of Professor Sadtler that I am able to publish the following results and I will quote him in his own words:

"We used a small furnace, containing 30 full-size retorts, which we purchased in Missouri. These retorts were lined by us with various basic ingredients, and after being carefully fired up in the furnace, were charged with ore. We lost, during the entire run of 89 charges, a total of 10 retorts, which were lost entirely by breakage, none of them having been corroded. This breakage was chiefly due to the fact that our workmen were not skilled in cleaning the retorts. This gave us a daily loss of one in 267, or a small fraction of 1 per cent., as over against the daily loss in Missouri, running on ores not containing an appreciable quantity of iron, of 3 per cent. It is my belief, that with properly skilled workmen, we could materially lessen this small loss. The ore which we treated in these retorts was very materially different from the Missouri ore, in which it was their rule not to place in the retorts a charge containing more than 2 per cent. of iron or 3 per cent. of lead, as exceeding these figures makes their loss by corroding too rapid. The ore which we treated ran variously, in the raw ore, from 16 to 30½ per cent. iron, from 1½ to 12.89 per cent. lead, from 2 to 9 per cent. silica, and from 16½ to 37½ per cent. zinc. The silver ran from 5 to 17 ounces per ton, and the gold ran from \$1 to \$11 per ton. The zinc we produced was assayed at the Grant smelter, and by two prominent assaying firms in Denver. It showed no gold or silver, these metals appearing to remain entirely in the residue. It showed variously from 0.52 to 1.12 per cent. lead and from 0.06 to 0.12 per cent. iron, both of these impurities being well within the limit allowed for first-class spelter. The residue was perfectly oxidized, contained some little carbon and all of the gold, silver, copper and iron present in the ore, and practically all of the lead. It contained from 4.2 to 8.5 per cent. of zinc by the smelter returns. As we were obliged to use rather dirty coal-slack in this experiment, we ran the silica in the residue somewhat higher than would be the case in regular practice, where we would, of course, use a washed slack or a selected pure slack for admixture with the charge.

"In regard to the preparation of the ore for the retorting: It requires crushing and roasting. It is not desirable to have too high a percentage of either silica or lead, not that they appeared to have injured the operation of the process to the extent that we did use them, but because it is poor economy to use so expensive a process as distillation on such substances as lead, which would derive no benefit therefrom, or such as silica, which is simply a dead weight. It would be found, in most ores, that it is desirable to concentrate prior to the use of this process, cleaning out such proportions of the lead and silica as can be done without undue loss of values. As the ore has in any event to be crushed before roasting, the concentration would not add largely to the cost of the process."

This process is essentially the Belgian process of zinc distillation with the important addition of a non-corrosive lining to the retorts. As has been previously stated, zinc smelters do not care to treat ores containing over 2 per cent. of iron or 3 per cent. of lead in the Belgian process, on account of the destruction of the retorts. In this process the interior of the retorts is protected from corrosion by the protective lining. Hence, complex sulphide ores, after roasting, may be treated in the Sadtler retorts for the distillation of their zinc contents. The residues carrying practically all of the gold, silver, copper, lead, and iron contents of the original ores are then in excellent condition for the extraction of their gold, silver, copper, and lead by the ordinary process of smelting for base bullion and copper matte in the blast furnace.

The Fry process for the treatment of mixed sulphide ores has been in operation at Swansea, Wales, for some time, but with what degree of commercial success the writer is not informed. The Smelting Corporation controlling the process have erected a new plant, having a capacity of from 100 to 150 tons of ore per day, on the Manchester ship canal, England. The roasted ore is mixed with about 25 per cent. of salt cake (crude sodium sulphate) before it is withdrawn from the roasting furnace. The salt cake, which fuses rapidly, agglomerates the ore which is then smelted in blast furnaces with the addition of a small quantity of iron oxide as flux. The smelting is very rapid and about 90 per cent. of the lead present is reduced and collects most of the gold and silver as in ordinary smelting for base bullion. About 90 per cent. of the zinc present passes into the slag. The slag is pulverized, mixed with fine coal, and heated in a Siemens gas

furnace, where the zinc is driven off as oxide, forming a product containing about 64 per cent. zinc. This product is reduced to spelter by the distillation process. About 80 per cent. of the zinc contained in the slag, or 72 per cent. of the amount present in the raw ore is recovered as oxide. The success of the process naturally depends largely upon obtaining a cheap supply of salt cake.

The Ellershausen process, which appears to be similar to the Bartlett process in operation at Cañon City, Colorado, has had in operation an experimental plant at Llanelli, South Wales, and at Angoulême, where considerable mixed sulphide ores from Broken Hill, Australia, Tasmania, and France have been treated.

Numerous experiments have been made in the treatment of zinc ores in both blast and reverberatory furnaces, but so far none have given much promise of success. The difficulty has always been in keeping the zinc reduced, no method having been so far brought forward for keeping the condensers free from carbonic acid and air. (See The Chemical Properties of Zinc.)

The use of vertical retorts with interior condensers has been proposed, and the endeavor has been made to make this a continuous process, but so far these methods have not passed the experimental stage.

A gas-fired furnace, with highly inclined retorts, has been patented by Thum. This furnace was designed to treat ores rich in lead. The retorts are open at both ends, the lower end being closed with a clay plug and the top end by an adapter. The zinc vapors escape at the top end and are condensed in the adapters, whilst the lead collects in the bottom. This method has not given satisfaction in practice.

WET PROCESSES OF EXTRACTION.

As metallic zinc is not precipitated from solution by any of the metals which are stable in the ordinary temperatures, the wet methods resolve themselves into a combination of a wet method and a dry method, or of a wet method and electrolytic precipitation of the zinc. Numerous wet methods have been proposed, and patented, and a number have been experimented with on a commercial scale, but so far without very promising results. The difficulties to be contended with in the economical extraction of zinc by these processes are: Great cost; the zinc is not obtained in the form of spelter except by distillation of a previously obtained product. Even where electrolytic precipitation is the method adopted for recovery of the zinc from solution the metal is generally precipitated in the form of zinc sponge, which has to be retreated for the production of spelter. With many ores the difficulties attending filtration and precipitation are great. Zinc has been recovered from poor ores and furnace products by means of sulphuric acid, hydrochloric acid, ammonia, ammonium carbonate, magnesium chloride, calcium chloride, iron chloride, and by subjecting the ores to a chloridizing roasting followed by leaching of the zinc chloride thus formed, the products being solutions of zinc sulphate, zinc chloride, ammonio-zinc hydrate, and ammonio-zinc carbonate, respectively. Whilst the combined wet and dry method of extracting zinc from poor ores has not at present passed the experimental stage, it has come into use in a few cases where the object is to separate the zinc, in the form of a commercial by-product as zinc vitrol or zinc chloride, from other valuable metals and metallic compounds. As want of space forbids a discussion of these processes in the present article, the interested reader is referred to Schnabel's Handbook of Metallurgy, Volume II.

ELECTROMETALLURGICAL PROCESSES.

The extraction of zinc by the electrolysis of molten compounds of the metal has so far not been attempted on a commercial scale, although numerous methods for its accomplishment have been proposed. For a description of these methods my readers are referred to Schnabel's Handbook of Metallurgy, and to Borchers' Electric Smelting and Refining.

REFINING OF THE CRUDE ZINC.

In the United States most of the zinc as it comes from the adapters is sufficiently pure, after skimming in the ladles, to cast into bars ready for the market. Such scrap metal as is produced, and any zinc which contains too high a percentage of lead, is remelted in cast-iron kettles which hold about 800 pounds. The melted zinc is stirred from time to time, then allowed to settle for some time, so as to allow the lead to liquefy out to the bottom of the kettle, the surface is skimmed off by means of a perforated ladle, and the zinc is ladled into iron moulds which form it into plates or slabs. If the metal contains much lead this is separated by allowing the melted zinc, after skimming, to stand for from 15 to 20 minutes, almost to the point of solidification, when the greater part of the lead will collect in the bottom of the kettle. This part of the contents of the kettle is kept separate, and if sufficient of this leady zinc is collected it is remelted and treated in the same way. It is difficult to regulate the temperature as it must be kept rather high, but not above a certain limit, or

considerable loss of zinc by volatilization and burning of zinc will result.

Very impure zinc, as that produced in Upper Silesia, is sometimes refined by remelting in a reverberatory furnace, which has a sloping hearth with a sump at the lower end for the collection of the zinc. The raw zinc is gradually charged into the hot furnace and is slowly melted until the sump is filled; the zinc is then rapidly ladled into the iron moulds.

THE EXTRACTION OF ZINC IN THE FORM OF OXIDE OR PIGMENT.

In some places, zinc ores are treated for the production of marketable zinc compounds, such as zinc oxide (zinc white), mixtures of zinc oxide, lead oxide, and lead sulphate (pigment), or zinc sulphate (zinc vitriol). For these processes, ores are selected which are not generally suitable for the extraction of metallic zinc, either because they contain other valuable or detrimental metals, as manganese, iron, lead, or silver and gold, or because they contain too small a percentage of zinc. Such ores are generally zinciferous iron manganese ores, as the franklinite ores of New Jersey, or complex sulphide ores carrying gold, silver, lead and copper, as the ores treated at the works of the American Zinc-Lead Smelting Co., at Cañon City, Colorado, or the complex sulphide ores of Rammelsberg, which contain considerable quantities of galena, iron and copper pyrites, and barytes, in addition to blende.

The production of zinc white from the New Jersey ores has been brought to a high state of perfection by the earlier inventions of Samuel Wetherill and the later inventions of his son, J. P. Wetherill. At present these ores, which consist of mixtures of franklinite, willemite, zincite, and gangue, which latter is essentially calcite but contains also rhodonite, garnets, and numerous silicates, is crushed, dried, pulverized, screened, and passed over Wetherill magnetic separators. The product of the Wetherill machines is fairly clean franklinite and a mixed, or middle, product of franklinite and various iron and manganese silicates. The tailings from the magnetic separators pass to wet jigs, where the willemite and the zincite are removed from the calcite. The concentrates from the Wetherill machines are sent to the zinc oxide works, and the concentrates from the jigs (principally willemite), which carry about 50 per cent. of zinc, are at present shipped to Germany, where they are treated by distillation, the product being a very pure spelter. The franklinite concentrates are treated for zinc oxide in Wetherill furnaces upon a grate, or upon a bed of fine anthracite coal resting upon the grate, zinc being thus produced, but being immediately burnt to oxide by the air and the carbonic-acid gas contained in the products of combustion; the zinc oxide mixed with the products of combustion is cooled down and collected in bags after the zinc has been completely burnt, and particles of coal and ashes have been separated from it, whilst the permanent gases evolved escape through the pores of the bags. In addition to the zinc oxide collected in the bags, an impure zinc oxide, forming from 2 to 3 per cent. of the total quantity produced, is collected in the flues, pipes, towers, and cooling chambers. This is generally removed once a week, and is either sold as inferior zinc white or is returned with the ores to the Wetherill furnaces, or is distilled in retorts for metallic zinc. The white deposited in the bags is removed from them by shaking and beating at intervals, and is collected in barrels. The residues contain from 1.2 to 6 per cent. of zinc, and as they are rich in iron and manganese, they are smelted in blast furnaces for spiegeleisen.

The Bartlett process in use at Cañon City, Colorado is, in its simplest form, as follows: All ores containing 20 per cent. or more of zinc are crushed to pea size, mixed with 10 to 25 per cent. of pea coal and dust coal, and blown up in a specially constructed furnace, using a blast of from 4 to 8 ounces pressure. It requires from 20 to 40 minutes only to drive off the lead and the greater part of the zinc and sulphur. A cinder is formed containing the silver, gold, and copper, in a matte mixed with more or less slag. This cinder is smelted in an inclined low blast furnace mixed with other suitable ores and fluxes to produce a high-grade matte. The zinc in this charge may reach from 15 to 20 per cent. and is mostly driven off as fume. The fume from the "blowing-up" furnaces and from the blast furnaces is caught in bags, mixed and refined in a suitable furnace, whereby carbon, arsenic, sulphur, and other impurities are eliminated, and a pure white pigment is produced, suitable, after being ground in oil, to be used as a white lead substitute. For a full description of this process the reader is referred to an article by Dr. Bartlett in *Mineral Industry*, Volume V. A similar process is in use at Joplin, Missouri.

At the Herzog Julius Works, at Goslar, and at the Sophia Works, near Langelsheim, zinc vitriol is produced from the mixed sulphide ores of Rammelsberg, which have been previously mentioned. The ores are calcined three times in heaps, by which a portion of the zinc sulphide is converted into a sulphate. Each heap contains about 500 tons of ore. The small ore, which is

separated after the various fires, contains the zinc partly in the form of neutral zinc sulphate and partly as a basic sulphate, which latter is insoluble in water. In order to remove the neutral sulphate the small ore is leached with hot water and waste solutions. The residues, after drying, are smelted for lead in blast furnaces, together with the lump ore from the third fire. The ore is leached four times, the two first times with the unsaturated solution from a previous operation, the two last times with hot water. The first and second solutions are mixed so as to produce a lye of 30° B., clarified, free from iron and sulphate of lime, and then evaporated down to the crystallizing point, when the zinc vitriol is allowed to crystallize out. The mother liquor is pumped back into the evaporating pans until it becomes too impure. A part of the zinc vitriol is worked up into calcined vitriol.

Mining in British Columbia.

Extracts from the Annual Report of the Minister of Mines, of British Columbia, as given in the U. S. Consular Reports, give the following facts:

The total mineral output of the Province for the year 1899 was \$12,393,131, as against \$10,906,861 for 1898, an increase of \$1,486,270, or 13½ per cent.

This would have been largely increased but for the shutting down of several mines, owing to the passage of a law prohibiting miners working over eight hours under drastic penalties, which completely demoralized the industry for some months, causing a deficit of \$910,844 in silver and lead values alone. It is believed that but for the shutting down caused by the legislation referred to (the penalties of which have recently been temporarily suspended), the same mines would have brought an increase of \$500,000, instead of the present deficit, making the years' increase \$2,863,159, or about 27 per cent. over last year.

The coal mines of the Province during 1899 turned out 1,306,324 tons of coal and 34,251 tons of coke, an increase over 1898 of 170,459 tons of coal and a decrease of 750 tons of coke. The total value of coal produced in the Province during 1899 was \$3,918,972.

The gold production for 1899—including both placer and lode gold—was \$4,202,473. The yield of placer gold was \$1,344,900, over double that of 1898, when the yield was \$643,346. The large increase was due to the discoveries in the Atlin Lake district, which, notwithstanding the disadvantage of the disputes regarding ownership caused by the enactment of the alien law, yielded \$800,000 in gold. The output of gold obtained from lode mining in 1899 was \$2,857,573, an increase over 1898 of \$656,356.

The amount of copper produced during 1899 was 7,722,591 pounds, an increase over 1898 of only 6 per cent. As yet, the copper-mining districts are practically limited to three—Rossland, Nelson, and the west coast of Vancouver Island. Rossland produces 75 per cent. of the total output of copper in the Province.

There has been a material decrease in the amount of silver produced in British Columbia, owing to the fact that the largest producing mines have been shut down since June or July, on account of labor troubles, as stated above. The total silver production for the year amounted to 2,939,413 ounces, valued at \$1,633,708, a decrease from the production in 1898 of 1,357,619 ounces fine silver and of value \$712,133.

The total lead production for 1899 amounted to 21,862,436 pounds, valued at \$878,870, as against 31,693,559 pounds, valued at \$1,077,581 for 1898, a decrease of 9,831,123 pounds of lead and of \$198,711 in value.

Some 2,000 tons of iron ore was mined in the Province last year—near Kamloops and on Texada Island—which was used for fluxing purposes by the smelters.

Lake Ore Matters.

The attitude of the Rockefeller interests in iron ore is the interesting question to all buyers of ore, as this company is far and away the largest seller of ore on the American market today. When this company offer to sell their best ore, a standard Mesaba, at a price on dock, Duluth, that returns no more than cost, and offer to contract any amount at this price for a term of years—as they are doing today—their position becomes of supreme importance. If they can sell every ton of this standard ore at from 50 cents to \$1 a ton above the price they offer, and that is the fact, why are the low figures made? The question is not a hard one to any man from the oil region, for instance. Cost, in the case of any Mesaba ore mined by companies controlling their own railways to Lake Superior, includes an 80-cent rail freight, in which is the very fair profit to the combination of mine and road. But to any independent miner not controlling a railroad this 80 cents is an actual charge. It is, therefore, to the interest of the Rockefeller company to keep freight rates by rail where they now are so long as possible. And by the same token it is their interest to hold up lake freights.—D. E. W. in *Iron Age*.

DRAINING GAS FROM GOB WORKINGS.

By Bore Holes—Where It Is Practicable—The Relative Advantages of Force and Exhaust Fans for This Purpose.

By Chas. Connor, Mine Inspector, Uniontown, Pa.*

This subject was discussed by this Institute at a previous meeting but was not finished, and whilst getting up this program, the time for which was limited, and to get enough papers was a matter that required some time, Mr. Fohl, the secretary, suggested that I take up this subject again. This is not so much in the nature of a paper on the subject as some thoughts that would lead to the discussion of this question. I have talked on this matter before and have had some experience possibly in regard to these matters, and I simply want to give you the benefit of my experience, what I have seen, what I know, and whether they would be productive of the results that have been claimed for them or not, and, as the subject indicates, whether or not it is a practical method of removing gas by means of bore holes. I have had some other thoughts which I desired to embody in this paper but was not able to finish it on account of the great pressure of other work to which I had to attend. What I have read* I will now supplement, in a disconnected way, perhaps, with some remarks in addition to what I have written.

I had expected to write some particulars with respect to the territory drained as well as the quantity of gas given off, the depth of the seams, and of the bore holes, which may be of interest, and last, but not least, something with respect to the cost of them. The bore hole described in my previous paper, the first one (three of them have been bored into this mine), was of a depth of about 300 feet and was 6 inches in diameter. It was drilled down from the surface until it reached the top of the fall.

Previous to this bore hole being put down, a current equal to 35,000 cubic feet of air per minute, was passing through the heading, and this failed to remove the gas in the gob. I measured this current two days previous to the hole being put down, and found that there was so much gas being given off that in that current of air, at a distance of about 50 yards along the headings from where it came out from the gob workings, gas could be detected in the entry by exploding in the safety lamp two feet from the roof of heading.

After the hole had been drilled three days I again visited the mine. The same current was going. I went into the places where I had found gas down below the roof from 1 to 2 feet, and out in the entry. When I went back the second time I went up at least 45 to 50 feet on the top of these falls—just as far as I was able to get—and I was unable to detect the presence of gas in these falls in any place that I could get into. Now, a fact like that is very much better than any theory and, as an illustrious person once said, it was "a condition confronting us, not a theory".

Before the bore holes were put down, gas was found in the gob fall in such dangerous quantities that it was absolutely dangerous for men to work in that portion of the mine, or indeed, in the adjacent portion by reason of that gas. Three days after that bore hole had been put down, the presence of gas could not be detected at all, showing clearly that this was a very effective means of removing the gas from that fall. The extent of area that was drained off was in the neighborhood of about 16 acres, and previous to the bore hole being bored we could get gas in any place around the edges in that area of 16 acres and from 1 to 2 feet below the level of the roof. Three days after it was put down we couldn't get it at any place, showing that it was draining off about 16 acres of territory, thereby proving conclusively, in that particular instance, the effectiveness of this method of removing gas.

In another portion of the mine a second bore hole was put down and under somewhat different conditions. They bored this hole 380 feet, drilled it down through into the coal before the pillars were withdrawn, with a view to draining off the gas from the strata. The result of that experiment was that it did not accomplish what was intended. The size of the hole was the same as the first one, 6 inches. A feeder of water was struck in this hole, which came down in considerable volume, equal to about 100 gallons a minute. The volume of that water coming down created enough suction to overcome the pressure of the force fan that should have taken the air and gas up through the hole. A considerable volume of gas was also drained through the strata with the water, and for a distance of about 20 feet around the bottom of bore hole a safety lamp would be filled with explosive gas. However, that did not appreciably affect the amount of

gas that was in the gob workings about this bore hole. It was still found about the same place, and it continued that way until pillars were worked back to where the bore hole was located and a fall made in the roof and the solid stratification broken, which distributed the force of the water that was coming down the hole, and at the same time made a reservoir for the gas immediately under where the hole was. After that was done, the stratification broken, and the gob made, then the gas in the gob began to diminish in volume, and gradually became less and less, and ascended higher in the falls, until, I think in about three weeks' time, if I remember right, we were not able to detect the presence of gas in that portion of the gob at any point within reach. This second bore hole seems to demonstrate this fact: That in order to be effective, three bore holes must be bored over falls or gob, and that the gas cannot be drained off through strata which are unbroken.

A third bore hole was put down some time last year, about June or July, 1899. This third hole was bored 370 feet in depth and was also 6 inches diameter, and was drilled down onto the gob, as had been the first. It was a part of the mine where they had reached the boundary line and had nothing but gob behind them, and no means of getting in between or behind the falls in any way to eliminate or carry off the gas. When the pillars had been extracted back some distance the gas seemed to increase very much; at first they did not have very much and could work along safely, but by and by it came lower down upon the falls until it got below the roof 18 inches, and 2 feet in some places, and it was with very great difficulty they worked. Indeed, they had to stop a number of places because it was not safe to work, and they could not put a sufficient amount of pressure by ventilating power in there to remove the gas from the gob, it simply removed a little from the outer edges of it, and there seemed to be volume enough of gas in the gob to supply more than the air was able to take off.

The third bore hole was put down, as I said, 370 feet in the same manner as the first one on the top of the fall or gob. A few days before this hole was down I measured the air current as before, and found it was 40,000 feet in that section of the mine. I discovered the fact that even when this latter current was circulated, they could not control nor keep in subjection the volume of gas generating in the gob, and they had to abandon part of the workings of the mine. A week after this hole was put down, I went up on those falls again as far as ever I could possibly go, 35 feet, at least, and I could not get any gas, was not able to detect gas by a safety lamp in any portion of that gob working, showing that in this case it was very effective, that it had the desired effect in removing the gas.

In the first bore hole that was put down I took samples and tested it on the Shaw gas-testing machine. The velocity of the air passing up was 2,000 feet per minute through the 6-inch bore hole, and when I tested the samples there was 50 per cent. of gas passing through that bore hole, showing that there was a large amount of gas. I have not made any tests of the other holes; however, there is not any question but that there must have been gas carried off, because it took it away from the mine.

Between the time of putting down the first bore hole in the Oliver mine and the putting down of the third, two more were put down in other mines in my district. Each of these was over 500 feet in depth. I might say, however, that the area of the territory that was drained by the second Oliver hole was about 12 acres, and the area that is being drained now in the third hole is about 5 acres, which territory they are still working at, and how much area it may drain before it becomes more effective, we cannot, of course, tell. The holes that were put down in Leisenring No. 3, were over 500 feet in depth and 7 inches in diameter, and drained about 13 acres of gob in each case. They were put down, as was the second hole at the Oliver shaft, into the solid coal before the gob or pillar workings had been worked to the point where the bore hole was located, and in each case, as in the Oliver second bore hole, they did not diminish the amount of gas that was in the gob until after the pillars were extracted and the falls made where the hole had been bored down. However, there was this difference, in each of these holes at Leisenring they did not have any water and there was a natural draft up both holes. In the second hole at Oliver, where the feeder of water was struck, there was a draft down against the air which brought the gas down; but in these two the draft was upwards through the hole and yet they didn't seem to diminish the quantity of gas in the gob workings until the falls were made back around the holes, after the pillars had been extracted. Now this shows, if it shows anything, that the value of bore holes for this purpose depends upon putting the holes down over where an excavation has been made, and that a hole will not drain off gas through the unbroken strata. It is reasonable to think that this is the case; because the pressure that would be necessary to force the gas from the gob through the strata to the bore hole would be very much greater than the pres-

*The preliminary part of this paper, which was read before the Central Mining Institute of Western Pennsylvania, December, 1899, was published in MINES AND MINERALS, June 1900.

sure producing ventilation in the mine. As a matter of course it would seek the least resistance, and of course, having greater resistance to meet through the solid strata into the bore hole it will not go there, but will fill up the gob and give off the surplus into the air as usual. What I mean is this: Where a bore hole is being put down ahead of where gobs are being made, or where pillars are being drawn out, it will not liberate the gas from that gob working until the pillars are extracted and the strata is broken and an excavation made into the bore hole. The pressure necessary for the gas to escape into the bore hole passing through the strata will be greater than the pressure that is keeping it in the gob by the ventilating pressure of the mines, and therefore, until the pressure is reduced to such an extent that it will be less than the ventilating pressure in the mine, it will not escape through the solid strata; but immediately after the pillars have been extracted and falls have been made around where this bore hole is located and the bore hole is opened to the fall and the pressure of the atmosphere can get at the gas on the fall and force it up the bore hole through the falls and not through the unbroken strata, then it will be removed, and it did so in both of these instances at Leisenring as well as in the cases at Oliver.

Now these facts go to show that this is a practical method of removing dangerous quantities of gas from mines where there are large gob areas filled with explosive gases, and that cannot be worked for that reason, and permits the danger to be removed and allows them to be worked safely.

An objection may be raised as to the cost of this method. If you take into consideration the area or the acreage that has been drained, and take the cost of a bore hole and divide that by the tonnage of that acreage, you will find that it is a very insignificant expense. Take a coal seam where, for instance, about 12,000 to 13,000 tons per acre are extracted, and multiply that by 10 or 16 acres. The cost of the bore hole would be about \$1 a foot. Even in these two cases, where the holes were 500 feet deep, the cost would be only \$500 each. Now divide \$500 by the tonnage of 16 acres of coal, and the result is so small a fractional part of a cent per ton that it is not worth speaking about. The cost, when figured out, is as follows:

Tonnage in 16 acres = 208,000 tons; bore hole cost \$500,
 hence, $\frac{500}{208,000} = \$0.0024$ per ton.

And when you compare the safety that is secured with the money that you expend, why then, there is no room for argument at all, there is no room for objection at all, because in several of the cases portions of the mine were stopped and could not be worked because of their unsafe condition, and by this means they were freed from that danger and were able to be worked, and to be worked safely; why the question of cost should not be a consideration at all, especially when it costs so little.

Then again, it may be objected that this method is only efficacious where we have a force fan. In other words, it may be said that where there is an exhaust fan that would tend to draw the air current down through the bore hole into the mine, it would have a tendency to bring the gas off the gob into the air current of the mine and thereby make it more dangerous than it was before. That may seem very plausible at first sight, and may be looked upon as a valid objection, but if you look into it I think you will find that it is entirely fallacious. If the gob workings are filled up with gas, and if the pressure is in excess of the ventilating current, the gas distributes or diffuses itself into the air current, mixes with it, and is carried through portions of the mine anyhow, even when you have no bore hole. If you have a bore hole, and the air is going down through it and into the workings of the mine, you would not have any more gas coming into the atmosphere than was in the gob, and the gas would not be any greater than it was before, after the gob was once cleaned. But if that argument is good, let us pursue it a little further. The air goes down the bore hole and brings out the gas from the gob; it is evident, if it brings out more than was formerly going into the atmosphere of the mine, it is bringing out some of the surplus, and it is leaving less gas in the gob. It may be that it is mixing with the atmosphere in greater volume than before, but by and by, if it comes with the air long enough, it will clear the gob of gas altogether and keep out the large accumulation that you have hitherto had in the gob, and therefore you have less danger even under that supposition. Even supposing that it is a down throw, and with an exhaust fan you will simply have the feeder of gas that is being generated in the gob given off into the atmosphere of the mine, and you have no reservoir of gas in the falls whatever. If it does not bring any more out than it did before, it is not adding to the danger, so that, therefore, you cannot increase the danger by any species of argument whatever on that ground. And then what is left to be done? Why, it has been demonstrated that you can remove it, and it has, in every instance, by using a force fan instead of a suction fan; simply convert your suction

fan into a force fan. With these remarks I will open up the way for discussion.

I think in any other location in the Connellsville region we could attain the same results we did at the places mentioned. The gas would only be uncontrollable until the gob would be cleared of the gas, by the air coming down the bore hole, when the feeder only would be given into the air current, as was the case before the bore hole was drilled, with this advantage that the gob would be empty instead of full of gas as was the case before the hole was put down.

Mr. Connor's remarks brought out the following discussion:

MR. ADAMS.—Mr. Connor, you said in order to make this method effective you have to bore right into the reservoir, that is, into a cavity, and unless it goes into a cavity then this method will not answer.

MR. CONNOR.—The bore hole should enter directly into the reservoir or cavity containing the gas and not into the solid pillar surrounding the gob.

MR. KEIGHLEY.—Without any other pressure than that of itself, we have gas being produced. There are holes drilled down into the solid strata, and why should not there be force enough behind them to drain that territory, if the gas has lodged in the upper strata in those reservoirs, because it has produced that gas and it has lodged in both the upper strata and lower strata. It is not liberated there, until the strata have been broken or cut. Now would it not be a fact, or is it not a fact, that you can drain the gas from that territory if you drill down through the strata if you strike fissures or the lodging places for this gas. Is not there force enough behind it of its own pressure to drain that territory. Are not there gas wells in this vicinity that are producing 300 or 400 pounds pressure?

MR. CONNOR.—It is true that we have bore holes from which gas is coming in the natural gas fields, but that is because there are no excavations down where that gas is coming from, and it is held by the pressure of the rocks and the bore holes are the only means of escape through which it can get, consequently, it comes from those bore holes. In the experiments that have been made, when the hole was bored down through the solid strata into the coal seam there was some gas coming through the strata, some of it coming up through the bore hole, but it did not diminish the quantity of gas that was away back in the gobs, for this reason, that it took more pressure to force the gas through the stratification into the bore hole and it would require more pressure to do that than was being exerted by the ventilating power, or in other words the ventilating pressure was less than was necessary to bring it through the strata into the bore hole, and therefore, that being less, the gobs were kept full and the surplus escaped back into the mine, just as it had been doing before. But immediately the stratification was broken and the resistance lessened to allow it to escape into the bore hole, then it escaped through the bore hole out to the surface. The unbroken strata through which the bore hole is drilled will not drain the gas from the gob workings beyond the point where it has been broken. You understand it is quite a distance away from the bore hole through to where the fall is, and the gas from the gob will not go through that solid stratification into the bore hole, because it would take more force to do that than it would to go back into the atmosphere of the mine. There is some gas that escapes through the solid strata into the bore hole from the solid strata itself, but not the gas back in the gob, because it has less resistance to get into the air.

MR. PETERS.—What acreage would one of these bore holes drain?

MR. CONNOR.—With the first hole we had 16 acres.

MR. PETERS.—What would you consider the capacity of one of these holes to take off gas?

MR. CONNOR.—One of these holes, with the conditions existing in the Connellsville coke region, would drain from 10 to 12 acres of coal territory.

MR. PETERS.—What would you consider the effect of a hole under the following circumstances. You have an exhaust fan and the elevation at the pit mouth is, we will say 1,000 feet, and your mine is a sloping mine, your lowest elevation being 850 feet and the point at which it would be necessary to locate your bore hole in order to reach gob workings would be at an elevation of about 1,250 feet. With an exhaust fan, under these circumstances what would be the effect of a bore hole?

MR. CONNOR.—The effect, in my judgment, would depend upon the laws of natural ventilation, and would change as the temperature outside changed so that at times the gas would go out the bore hole, at other times go into the mine. There are other conditions that might come in which would modify that. On the top of the falls, in our region, we have a great deal of heat generated, and from the fact that firedamp is lighter than ordinary air and also because of the fact that it lays away back up in a still atmosphere, it would tend possibly to go up naturally

because of its rarefaction; it would not come down into the heavier atmosphere of the mine unless the pressure of the fan would counteract the motive column due to the temperature of the gas. That motive column would have a tendency to counteract the influence of an exhaust fan in bringing the gas down into the mine. It is a question whether the one wouldn't balance the other, according to the conditions. If you had an inch of water gauge, and an exhaust fan, and you had a very high temperature in your gobs and that lighter air up in there—it is generally away from any current—it is a question to me whether that light air would not go out against the operation of an exhaust fan. But that is not really a question of speculation but a question for demonstration by calculation. As I said in my remarks the gob or fall is full of gas to begin with, before you put that bore hole down. Now, even at the worst, if it brought the gas out of the gob into the atmosphere of the mine you would only have the original feeder of gas circulating through with your air current, which you had before you had the bore hole, and if you clear your gob of gas, you take away the reservoir, which is the element of danger. Now if the bore hole by means of an exhaust fan cleared the gob and forced the gas out into the current of air it would be only for a limited time until the gob was cleared of gas, and you would simply have the feeder then being brought into the atmosphere of the mine that you had previous to the bore hole being put there. Now, if you can work your mine successfully with air that has been diluted with the feeder of gas and eliminate the danger of having a large volume of standing gas, even in that case it would be an advantage. But with the appliances we have today, where we can change by the shutting of a door from one system of ventilation to another, that ought not to be a question to be considered. With even an exhaustive method of ventilation you have the danger removed, and you only have gas that has been diluted with the air current in the mine.

MR. PETERS.—Which did you use, a blowing fan or an exhaust fan?

MR. CONNOR.—We had a blowing fan.

MR. KEIGHLEY.—Do you know that with those fans the water gauge is only $\frac{1}{8}$ of an inch. Suppose you reverse the fan, you would only have twice that amount of pressure, that is, you would only have $\frac{1}{4}$ of an inch water. Where do you get your pressure? There is only $\frac{1}{8}$ of an inch water gauge in it; if you reverse that you certainly could not have any more than $\frac{1}{4}$, and in the suction fan or exhaust fan that is not enough to overcome the gas; that is a matter of calculation. With the style of fan we have I do not believe we can get up power enough to reverse that current. I do not think it is possible, because the hole is only 6 inches in diameter; the friction in that hole is so great that the exhaustive power would amount to nothing at all.

MR. ADAMS.—With your experience in the working of the Connellsville coal, could not the coal be extracted on such a method that you would not have those reservoirs of gas?

MR. KEIGHLEY.—No sir, you cannot do that. They say that by going right up to the surface you let the gas escape. It will not do it in our district. We have broken our cover right up to the surface and still we have gas right down in the mine. We have a stratum of hard rock and a stratum of soft rock, and we have falls right at this very time in the second section, No. 2, Oliver mine, 600 feet deep. That roof is broken clear to the surface and still there is gas there level with the roof in the workings.

MR. STREET.—Under the system of ventilation given, with the air current sweeping at a rate of 40,000 cubic feet per minute along the edges of these fallen places, we find when we liberate the gas that the current will go so far past the last breakthrough and then forms a wall and holds the air at bay. Now then, if you will agree with me in that, I hold that the gas that was above these falls and gobs was simply held there in suspension by the pressure of air below it.

MR. ADAMS.—I don't understand that.

MR. STREET.—The air will only go so far, I don't care what ventilating power you use. It will only go so far beyond the last breakthrough. If the exhaustive current was sufficient to create a down current in the bore hole then it must bring the gas from the top of those falls and distribute it into the air current. But with a forcing ventilation the opposite is the fact. The light gas is located so many feet above the current that is flowing all around it, or flowing in front of it. Now then, you have provided a vent for that lighter gas to escape, and what can it do but go. It is like the Irishman said about Niagara: "There is nothing to hinder it." In our anthracite region we have to carry air up chutes, and some of them are very steep. Why could not air be carried into the falls and those currents kept separate, if possible, from the ventilating currents and the air or the gas carried through there? Section 5 of the law provides that you shall not have this gas

standing. What I want to present is this: That with a forcing ventilation I believe that this is possible, that it has been done, and the gas is more easily removed than it could be, perhaps by any other system, unless in the case of Mr. Keighley, who tells us that he has only about $\frac{1}{8}$ inch water gauge. If Mr. Keighley was capable of producing a current sufficient to sweep those gobs and bring that gas into his mine in his air current, dilute and carry it off safely, that would be the proper method. In my experience in this section, in liberating and carrying pent-up gases with an exhaustive ventilation I have found blackdamp a great deal worse to contend with than the gas that was in the gobs, have found it more dangerous and harder to overcome.

I have in my mind the same thought that Mr. Adams has: A bore hole drilled in solid strata will emit gas 2,100 feet down in solid strata, and it will emit it continuously for years, and burn for years. Now comes the question: Why won't the bore hole at Oliver do the same? The reason that it did not do it, the reason that it cannot do it, and the reason that it won't do it is, that the air coming in keeps the gas in suspension or abeyance, and the water falling down prevents it from escaping. It couldn't have come through the solid strata to the bore hole because the air was in the mines. It did not escape from the solid strata into the hole because it was held in abeyance or in suspension by the air by which it was surrounded. While this may be possible, while it may be practicable with a forcing system of ventilation, I would not regard it as practicable with an exhausting ventilation unless the ventilation coming from this section of the mine was kept in a separate current and liberated in safety beyond the workings and the workers, unless diluted with a sufficient quantity of air to make it non-explosive. If that air could be carried off by suction, exhaustive ventilation, and kept in a separate current, the expense of the bore hole will be obviated. And, as I take it, with the ventilating current necessary to remove this gas, would it not be better to remove the gas in the ordinary way than by these bore holes?

MR. KEIGHLEY.—Mr. Street speaks about removing the gas by forcing ventilation. We tried that. We went to the next section beyond the first fall and opened through the barrier pillar (100 feet thick) and brought the current of air over the gob, and we had to take the men out of the mine. It simply bored a hole through the cavity and took what gas it could reach and left the rest right there. Mr. Ross, mine inspector, was the man that did it. He was then mine foreman of Oliver mine. We did not resort to the bore hole until we had to, because it was a pretty expensive matter, and it was in opposition to the judgment of the mine inspector of the district at that time, Mr. Duncan, Mr. Connor's predecessor. Before we put down this bore hole we discussed the matter pretty thoroughly; we did not put it down in a day, we talked about it probably a year. Mr. Duncan went to every mine in the region where there was a bore hole, and he came back and told me that in every case, whether the mine was ventilated on the forcing principle or the exhaustive principle, the current was invariably down, and he told me, told Mr. Ross, and told a number of others that there was no use putting that hole down, that when we put that hole down that it would be a down-cast, while we had a great volume of air there, we would not have enough water gauge to overcome the down pressure. In the meantime Mr. Connor was made inspector (succeeding Mr. Duncan) and we put down the bore hole. So far as expenses are concerned, I think we spent 10 times as much money as that bore hole cost, to get rid of that gas by bratticing and changing air currents. Mr. Ross has had 20 men there sometimes, trying to force out the gas, and we have shut off the whole mine and even put the whole ventilating system in one current. We have no less than 17 overcasts. Before we put down our third bore hole we had a 10-foot and a 20-foot fan. I came down to Pittsburg and told my employers the condition we were in. They told me to get another fan. We had that fan shipped from Brazil, Ind., by express. The express charges were more than the cost of the fan. We put up the third fan, and still could not do anything. We went back to the old plan (the bore hole), a plan that has been recommended by everybody, and in three days after it went through we had no gas. When that bore hole went down into our mine, the velocity of the gas escaping up the bore hole was 2,000 feet a minute. As to the limits of one of those bore holes, nobody knows it. Sixteen acres is not in it; 16 acres is what we have drained of gas at one time by bore holes. I think we have a territory of 1,400 acres, and I do not believe we will ever have to bore another hole. You had better put in three bore holes to 1,400 acres. I never expect to have to put down another one in that territory. We have gone to our boundaries and we cannot go any farther, we are back from our boundaries in some cases 800 or 900 feet, so there is not any use in talking of 5, 10, or 16 acres; I do not believe anybody knows what a bore hole will drain.

MR. DE ARMITT.—Have you ever tested to see how much gas was coming out of the pipe?

MR. CONNOR.—I said the velocity was 2,000 feet per minute, and I measured 50 per cent. of gas coming out of the hole.

MR. KEIGHLEY.—When the first hole was put down I went to the driller and told him to move his boiler back and he did not want to do it. I told him if he did not I would have the mine inspector on him so he finally removed his boiler and we laid a steam pipe about 1,000 feet, I think on the ground, to that well. We got the hole completed and everything went all right, then some boys came along and set the gas on fire. In the third hole, the men that drilled it were old experienced oil- and gas-well drillers, but I told them about their boiler. I said "You will have to be careful when you strike through into that gob. Gas will certainly reach your boiler." They said, Oh, no, they knew their business, that they had had experience, and said their boiler was far enough away. They struck down into the gob and we took those measurements and they stopped work that day. The next morning they started to take down the rig, one went up on the derrick and the other one started the fire in the boiler and away went the gas. In that case the length of flame was 50 or 60 feet, so there is no mistake about what came out of the hole.

MR. DE ARMITT.—How long did it continue to flow at that rate?

MR. CONNOR.—The last measurement was 900 feet.

MR. DE ARMITT.—What percentage was gas, and if there was no gas, was there not air escaping?

MR. KEIGHLEY.—I do not think there is any air coming up, we cannot get back of the gobs any more, after we get two or three falls with our roof the gob is packed tight.

MR. DE ARMITT.—I understood Mr. Connor to say that 50 per cent. was gas and 50 per cent. air.

MR. CONNOR.—That was at first, in the first hole. I am speaking of the present time.

MR. PETERS.—Would you consider an exhaust fan the proper method of ventilating a mine where there were bore holes to allow gas to escape, or, in other words, would you use an exhaust fan?

MR. CONNOR.—I would not like to put it that way. If a mine was equipped with an exhaust fan I would do just exactly as was done. I am satisfied that is the way to get rid of the gas. If we had a propelling fan in which you can get a water gauge of 10 inches, that would be a different question, but with an exhaust fan of usual type you cannot get a water gauge which will prevent the gas escaping up through the bore hole.

MR. BLICK.—Putting the question more direct: In case you have bore holes to allow the gas to escape, what is the proper method of ventilation, force or exhaust?

MR. CONNOR.—Did you say if you have bore holes for the purpose of allowing gas to escape, what is the proper method of ventilation, force or exhaust?

MR. BLICK.—Yes.

MR. CONNOR.—A man does not generally change his fans to suit bore holes. A man would hardly change his ventilating system for the sake of putting down a bore hole. I would not reverse my fan because I put down a bore hole. The great trouble has been this: It is not for lack of volume of air in circulation that accumulations of gas exists in gob, but it seems when you turn a current of air into a large body of gas it simply bores a hole right through it, it just goes through it and it takes what it can reach and leaves all the corners. That is what everybody experiences in every-day ventilation. You can ventilate right around the faces but you cannot reach back. And the same holds good in a large gob. You can only reach the gas as far as your power will reach it and no more.

MR. SEDDON.—Mr. Connor, you being fully aware of the conditions and circumstances in connection with the Umpire mine immediately after the explosion on September 23, 1898, and owing to the fact that gas in that mine is in about the same quantities at the present time, do you think that a bore hole would have relieved this mine of the gas?

MR. CONNOR.—With the conditions there, not having very much water gauge or ventilating pressure, I am inclined to think that part of the mine could have got relief from gas by a bore hole, due to the head of motive column that would have been obtained in that portion of the mine, and the gas there would not have come out into the atmosphere of the mine but would have gone into the bore hole, even with the exhaustive system of ventilation. I do not remember what the water gauge was, but I do not think it was over $\frac{1}{8}$ or $\frac{1}{4}$ in., and a bore hole there would have practically eliminated the gas from those gob workings.

MR. SEDDON.—I visited the Umpire mine two weeks ago and I found gas still present. Now that covers an area of more than 4 acres, it is not far distant from the place of the explosion. Do you think it would be advisable to put down a bore hole yet?

MR. CONNOR.—Yes; I simply answer that question by repeat-

ing what I have already said. A bore hole there would be an effective means of draining off the gas out of those gob workings, provided they are all connected. Let us understand the position. The condition in the Umpire mine and the conditions in the mine that I have referred to are entirely different. In the Umpire mine they are not properly gob workings in the sense that we talk of gob workings. When we talk of gob workings the strata are all broken down and there is no solid stratification. In the Umpire mine that is not the case. In the Umpire mine you have simply a series of falls in the rooms, with intervening spaces of solid strata between rooms, and you would have to put a bore hole down into each room to drain the gas out from each place to be effective in the Umpire mine, because it would not go through the stratification from one room to the other into the bore holes; but, if the conditions were as in a gob working, where falls have occurred in the rooms and the pillars not extracted, then I do not think the bore hole would be of any use. From my examination of that mine at that time, I am inclined to think that there is no connection whatever, and that the stratification is not broken up in the sense that could be called gob workings, that would be of any value whatever in draining off bore holes, and that it would not be capable of draining one from the other unless there was a bore hole in each room separately.

MR. SCHELLENBERG.—As you know the gas and the oil come from coarse sands where there are cavities and where there is a connection over large areas, or reservoirs, and the pressure of the gas keeps up probably according to the head of water in those porous strata, because we find that, counting 2½ feet of water head as equal to a pound, that about balances the pressure of these walls. Where they are tighter up the gas lets go until it is shut in, and then the rock pressure goes up, but it is the quantity of gas that can pass through open stratification that governs the open pressure, and I think that this is exactly the case in the Connellsville field, which has the Redstone coal near the Pittsburg vein, so that the whole thing is connected and there is open stratification there. The indication throughout is that there is a large space over a large area to draw from for keeping up the pressure. You understand that this open rock in the gas and oil field has to be pebbly. If you have a tight rock you can get a high pressure by shutting in the gas, you can go up to 800 pounds, but an open pressure may be only 2 pounds, but if you have a pebbly rock you have a high open pressure, you have a large area to draw from. You have in Connellsville a large area to draw from for your gas. Farther down towards Pittsburg it is not quite that way, and it is only in the vein itself that we can get the pressure.

MR. KEIGHLEY.—I have known gas to come back 500 feet in less than an hour's time, especially when we first opened out. Of course, it is not so strong now.

MR. DE ARMITT.—I think Mr. Schellenberg's remarks would answer Mr. Adam's question in regard to the gas not forcing itself through the strata into the hole. In the gas hole it comes through the sands instead of the solid strata.

MR. LOUITT.—There is no comparison between Connellsville and Umpire mines. As our friend Connor says, the ribs are still in there, they may be squeezed, but the cavities are under them, and my opinion of those holes is that they are not a success all the time, because even in the Connellsville region the cavities will be under them, and there is also the possibility of gas reaching where it cannot be reached by boring because you cannot get the air to it, or the movement of the air. An examination was made of the Umpire mine from this No. 2 room up to No. 15, where the trouble is, and it was found that No. 13 is the unlucky No. 13 still, the most gas being found in No. 13, that is where the trouble began and where the explosion occurred. A bore hole there would have to be put down, I suppose, in every room.

MR. KEIGHLEY.—I believe the program has reference to gob workings.

MR. CONNOR.—I would like if the discussion would be kept to the title of this subject: "Is a bore hole a practical method of removing gas from gob workings in deep mines?" Now, if I understand what gob workings are, it is where the coal is removed entirely and the gob has taken the place of the coal. This thing of abandoned workings, where falls have occurred in rooms and the coal has been only partially excavated, are not gob workings. I have argued all along on the lines that we have gob workings, and I want to say right here and now that I do not believe that a bore hole would be of any use whatever under the conditions of the so-called gobs you have in the Upper River Pool mines, because you have not any gobs in that sense. I want to say that so-called gob workings in the Pittsburg vein, in the mines mentioned, are not really gob workings, and when they ask questions as to whether a bore hole would be effective in such mines I want to say that what are commonly called gob workings in the above locality are not properly gob workings—they are simply

abandoned workings. In a large number of their mines they make no attempt to draw pillars at all, and just as in the Umpire mine, where there are a series of falls, with intervening spaces of solid stratification between, which extends over a very great area, they have simply a squeeze right there in that hill, and those bridges, or whatever you may choose to call them, are intervening, and what you call gob workings are simply abandoned workings. Now the proposition here is for the removing of gas from gob workings from which the coal has been extracted and the roof has been broken, and I want to say that I do not believe a bore hole would be of any service whatever in mines where the pillars have been left in and these squeezes have occurred, and the facts here presented only occur where you do have gob workings and the connection is such that the gases can get over an extended area of even 16 acres, where the coal has been extracted.

MR. SCHELLENBERG.—That is, there has to be a reservoir of gas?
MR. CONNOR.—Yes, that is the case.

SIGNAL-DEVICE FOR MINES.

An Arrangement to be Used in Connection With Bell-Signal Apparatus to Ensure Ease and Accuracy of Operation.

By C. S. Herzog, Virginia, Minn.*

Some time ago, in Mexico, our signal-bells in a 700-foot shaft caused us considerable annoyance by continually getting out of order, each time so delaying our hoisting operations that we naturally desired to remedy this evil. There were two ways open: either to patch up the old bell, which was of the ordinary pattern, every time it failed to work, or else to devise some new arrangement. On consultation with our foreman we designed a signal-device which, during the number of months I watched its operation, worked satisfactorily, without once getting out of order.

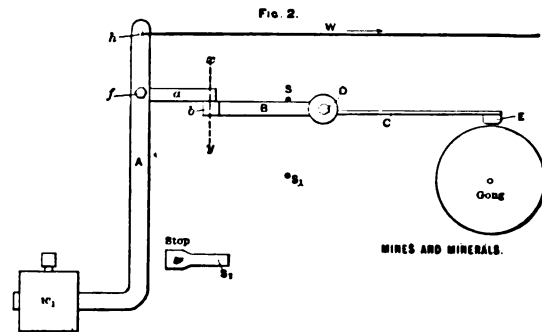
We sought to produce a simple device, in which no greater pull on the lever would be necessary from one level than from another; to counterbalance independently the weight of the pendant bell-rope, so that there would be no direct weight on the working-parts of the bell itself, and likewise to arrange it so as to necessitate only a light pull on the lever in signaling; and, finally, to make some sort of trip-arrangement, so that whenever the signaling-lever underground passed through a certain arc the signal would be given in the engine-room. By this means we wished to obviate the ill effects of sudden heavy pulls and rough usage in general, such as all signaling systems encounter underground at the hands of careless or mischievous employees.

The bell-rope we had in use was a galvanized iron rope $\frac{7}{32}$ inch in diameter; and, after determining the length needed,

further end, resting on a similar surface b on B . A cross-section through xy is shown in Fig. 3.

B is a piece of flat spring-steel about 8 inches long, at the end of which is the bearing surface b . D serves as a hub, to which B and C are attached; C being a flat spring similar to B , but about 12 to 14 inches long, at the end of which is the knocker E . It should be observed that B is vertical, whereas C lies flat, and that C should not be as heavy a spring as B .

When the bell-rope is pulled to signal the engineer, the wire W moves in the direction of the arrow, and the arm a traveling downward in a circular path, around f as a center, forces b to move downward around D as a center, until the arcs in which they are traveling diverge far enough for gravity to carry $B-C$



back again to its normal position, B being arrested by the stop S ; however, the force with which the arm flies back causes the knocker to strike the gong, and thus give the signal. As soon as the bell-rope is released the arm A is carried back to its original position, and in so doing the triangular surface on the end of a slides upon the inverted triangle b (see Fig. 4), forcing it to one side (see Fig. 5), until a rests in its normal position on top of b , when it is ready for another pull, as shown in Fig. 3.

In counterbalancing the weight of the pendant bell-rope, sufficient weight must be added to the counterbalance to bring the levers underground back into position automatically. The counterweight may be located at any convenient place on the head-frame, providing it is above the bell-crank to which W is attached.

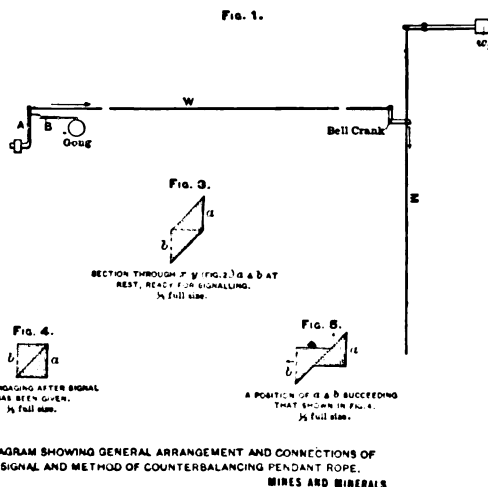
In order to prevent the pull necessary for signaling from becoming excessive, it is desirable to reduce friction as much as possible. A force equivalent to a 10-pound weight should be sufficient for pulling the levers in a well-arranged signaling-system. To accomplish this, I think it advisable to bring a bell-rope into proper alignment by means of plumb-lines, and to hold the rope in position by short pieces of old iron pipe 2 to 3 inches long, instead of by means of staples, as is so commonly done. In inclined shafts the bell-rope should be supported at frequent intervals on some form of roller. The spools on which connecting-wire comes make good rollers, in the absence of anything better.

That there may be no mistake, the arm C should be long enough, and the knocker E heavy enough to cause their instant return to position when the paths of a and b part company. For this purpose it is also advisable to put a stop, S_1 , below B , so that by no possible chance can it fly beyond its balance-point.

By increasing or diminishing the bearing of the triangles a and b , the arc traveled can be changed. In my opinion it is not advisable to increase this bearing above the inch mentioned before. The triangles, as shown in section, Fig. 3, should have bases of about $\frac{3}{4}$ inch, with perpendiculars of $\frac{1}{2}$ inch to 1 inch. The bearings of the two points f and d should be good ones, so that there will be no lateral motion, which might make a fail to engage properly with b . Any play at d or f is considerably magnified at the triangles; but by making the bases of these triangles large enough, the chances of their not working properly are greatly lessened. By moving the position of h with respect to the center f , the arc of pull underground necessary to signal, can be regulated.

The spring B must be quite stiff and of good material; but it must be borne in mind that the stiffer the spring the heavier must be the weight w_1 , and, in consequence, the greater the effort required to pull the levers; nevertheless, w_1 must be heavy enough to bring back the wire W and to overcome the resistance of the spring B . If the arm A is made sufficiently heavy, the use of a counterweight (w_1) may be dispensed with, although it is preferable to arrange as shown in Fig. 2; for by this means it can be properly adjusted. If w_1 is too heavy, the arm A has a tendency to pound against the stop S_1 . While w_1 must not be too heavy, its weight must not be cut down to such an extent as to impair the instant return to position of the arm A .

The whole apparatus may be mounted on a board and placed at some convenient spot in the engine-room.



we calculated its weight, so that we might be able to counterbalance it properly. On locating the bell in the engine-room a wire W is led off horizontally, and, by means of a bell-crank, is connected to the main signal-rope M passing down the shaft (see Fig. 1). The weight w_1 counterbalances M , and should be heavy enough to carry the wires back to a normal position, therefore it must be equivalent to the weight of the pendant rope M , plus a factor to overcome friction.

The working parts of the bell itself are shown in Fig. 2. A is a weighted lever, to the upper end of which the connecting wire W is attached; the arm a projecting from it is made of steel, about 5 inches long, and has a bearing-surface of 1 inch at its

*Transactions of the American Institute of Mining Engineers. (Canadian Meeting, August, 1900.)

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IOWA EXAMINATIONS.

THE Legislature of the State of Iowa on March 17, 1900, passed a Bill requiring the examination of mine foremen, pit bosses, and hoisting engineers. The mining interests of Iowa are not such as to cause her to rank foremost among the mining states, but in point of intelligence she stands we believe second on the records of the last census. It is to her credit as a mining state, that she has thus recognized the necessity of such legislation and the advantage accruing from a law requiring that officials charged with the responsibility of mining work, and to whose care and intelligence is intrusted the welfare of so large a number of men, should hold certificates of competency permitting them to discharge the duties of their office.

These examinations in Iowa are to be conducted by the examining board appointed by the Governor for the purpose of examining candidates for the office of mine inspector. The personnel of the present board of examiners is as follows: Floyd Davis, Des Moines, president; James E. Stout, Des Moines, secretary; Alex. Dargavell, Centerville; John Owens, Beacon; J. W. Lewis, Hiteman. At a meeting of the Board held in July, it was decided to hold the first examination under the new law at Albia, on August 6th and 7th for hoisting engineers, and August 8th and 9th, for mine foremen and pit bosses.

There is naturally more or less anxiety about the first examination under a new law, particularly where so large a number of persons are affected. Many of the men who are at present filling positions as mine foremen, pit bosses, and hoisting engineers and who have for a long period served in such capacity, have not the knowledge that would enable them easily to pass an examination in regard to the technical points connected with their several duties. Many are practical mechanics, conscientious and careful in the performance of their duties, and the new law in some individual cases might seem at first sight to throw an unnecessary burden on them when it requires them to be examined. It is undoubtedly true, however, that technical knowledge in regard to any line of duties, renders men more capable and thorough. Such knowledge gives them a broader and more discriminating judgment, and makes their opinions and calculations more intelligent, and their service more trustworthy. While it is true that many men who have served in an official capacity for a long period of time, but who have not a technical knowledge in reference to the details of their work, often prove of greater value and reliability than others who possess technical knowledge but who have no practical training; yet on the other hand it will not be denied for a moment that technical knowledge when possessed by the practical man renders him more efficient and capable. The need of this technical knowledge is becoming more and more recognized every day by practical tradesmen of every class, and the tendency is at the present time, to fill all of the more responsible positions, especially those to which are intrusted the lives of men, with competent certificated officials.

The Iowa law allows men holding these positions in Iowa, until January 1, 1901, to provide themselves with a certificate of competency from the examining board. The law does not affect men in charge of such work at mines whose output does not exceed 25 tons. The law also provides for the granting of a certificate of competency "To any person who shall produce satisfactory evidence that he has for a period of four consecutive years immediately preceding the examination, continuously and capably performed the duties of mine foreman, pit boss, or hoisting engineer, as the case may be." This provision for a service certificate to be granted to such as had performed the duties of their office for a period of four consecutive years immediately preceding the examination, was deemed advisable in order that many practical and reliable foremen and engineers should not be rendered ineligible to an office which they had filled satisfactorily for such period, simply because they lacked a technical knowledge of their duties. In the revision of the Bill as it was

originally presented, Section 1 was altered to apply to mines having a daily output in excess of 25 tons instead of 10 tons, and the following clause was added to the section:

"But in case of the discharge, resignation, or disability of any person lawfully performing such duties, the owner, agent, operator, or managing officer of said mine shall have a reasonable time within which to secure the services of a certificated person to take the place of the one so discharged, resigned, or disabled, and during such time a competent and capable person, whether certificated as provided in this act or not, may be temporarily employed to perform such services."

Section 3 was also altered to provide for the expenses of the Examining Board, and the latter clause of the section made to read as follows:

"The members of said board shall receive the sum of five dollars per day for every day actually employed in the discharge of the duties imposed herein, together with their actual expense incurred in the performance of such duties, which expenses shall be itemized and verified as provided by section 2480 of the code, but they shall not be allowed compensation for more than seventy days in any one year."

We have received many letters from Iowa since the passage of this law, asking for information in regard to the probable character of the examination, and where and when such examination will be held; also asking for advice in reference to the preparation necessary for the examination. The examination will probably be largely of an oral nature, and be made as practical as it is possible to make it. We have recently talked with several members of the examining board, who have expressed the desire and intention of rendering the examination as practical, simple, and direct as possible. They recognize that if a difficult examination were to be presented at this early date and with the short time given the candidates for preparation, considerable confusion and embarrassment might arise. Men whose experience in mining and in the operation of hoisting engines would warrant their employment in these capacities, could satisfactorily pass a thorough, practical examination in regard to the operation of mines and of hoisting engines, etc., who would not be able at the present time to perform the several calculations required in a technical examination in regard to these subjects. We think we are, therefore, safe in saying that the judgment of the board will insure a fair and thorough examination on a practical basis. In regard to the best manner of preparation for the examination we know of no better way than for all mine foremen, hoisting engineers, and other men connected with mining, who desire to pass such an examination, to employ their spare time in the study of such questions as are regularly propounded by examining boards. For many years it has been the custom of MINES AND MINERALS to publish the questions asked in the examinations conducted in the several States and to give to each question the best and most complete answer we are able. These questions and answers are published each month in the department "Examination Questions Answered" and we believe a careful study, from month to month, of these questions and answers will best prepare men for similar examinations, as they show the character of the questions which are being asked. In this same department, there are also special short articles which bear upon these questions and which explain more thoroughly than it is advisable to give in the direct answers, the principles involved in the questions, or the method of calculation of the examples. It is the aim to make these articles as practical and valuable as possible to men who are preparing themselves for examination.

The adoption by the State of such law is evidence of the growing appreciation of and necessity for technically trained and educated men. While the examinations for a few years will probably be comparatively simple and largely of a practical nature, if we can judge from the experience in other states where similar examinations have been held for a number of years past, it is safe to predict that these examinations will gradually become more difficult and that it will require more technical knowledge to pass them. It would, therefore, be the part of wisdom for all those who are looking forward to holding such positions in the future to at once begin to prepare themselves by adopting a regular and

systematic course of reading and study. MINES AND MINERALS is desirous of assisting its readers in all such matters in every way possible and it will in future, as in the past be always ready to advise and counsel with any one who writes for such assistance.

TRUE FISSURE VEINS.

NO term in the entire vocabulary of mining and metallurgy has probably been more abused nor more unworthily used than has "True Fissure Vein," unless it be that kindred and equally overworked and abused expression "Increasing Richness with Depth."

Prospectuses without number have used and are using "the true fissure vein" as a bait and as the open sesame to the guileless investor's pocket.

A number of very reputable eastern dailies have during the past year contained glowing prospectuses and advertisements of zinc propositions in the southwest, with the Joplin District, Mo., of course, as the center. These prospectuses have laid great stress upon the true fissure character of the deposits underlying the prospectused properties. To the mining man this is, of course, a ludicrous absurdity, and it is difficult to imagine anything much further removed from a true fissure vein than a Missouri zinc deposit. To the tenderfoot investor, however, the promise of zinc ore of the quality found comparatively near the surface in Missouri, extending to the depth of the great fissure veins of the Rocky Mountains, is a most alluring prospect.

As commonly understood and as the prospectuses wish it understood "a true fissure vein" is a mineralized cavity in the earth's crust extending to a considerable depth below the surface. The vein stone carries the pay ore and this may or may not continue with depth. As far as depth is concerned, it is by no means settled that fissure veins extend any deeper into the earth's crust than do bedded deposits, pipe veins, or contact veins, and even if they do extend to indefinite depths this is of little value, as the limits of economical mining are reached at comparatively shallow depths. A report or a prospectus which figures on deposits of unlimited depth is simply playing on the ignorance of the investor.

The fact that many of the fissure veins of the Rocky Mountains and Pacific Coast regions have contained rich deposits of precious metals has made this term "true fissure vein" an easy one to be used on the unwary. There is a very alluring ring to the sound of the words and they make a most eloquent text for the promoter. The investing public is easily intoxicated by a few doses of true fissures. A practical miner also readily grasps hold of a true fissure vein, and the first ring of his pick satisfies him that he has the genuine article and that it has its tap roots in the antipodes.

Properly used, the term "true fissure" is useful and very descriptive but where used as an incantation to call up visions of wealth extending to unlimited depths it needs suppressing.

OILS AND OILS.

WE have reason to believe there is a very common and popular delusion regarding oils. A man thinks when oil signs appear on his farm or when he has bored and actually struck oil that he has struck something of great value. There are oils and oils; there are some, and these far in the majority, that are of little commercial value, being too heavy for illuminating purposes and only good for second-class lubricating purposes, for which there is only a comparatively small market.

In Colorado, while there are numerous localities known to carry oil, there is but one, viz., that of Florence, which contains oil of sufficient lightness to be of valuable illuminating quality. The horizon in which oil occurs in Colorado, so far as at present discovered, is mainly in the shales of the Marine Cretaceous. This is a widespread and very thick formation occurring nearly all along the flanks of the Rocky Mountain range and in the parks of Colorado. The same formation also carries the heavy oils of

Wyoming. There is no reason why locally this formation, under favorable conditions, should not carry the valuable light illuminating oil in other places besides at Florence, but so far such has not been discovered.

The chemical conditions for an illuminating oil require a specific gravity of 30 to 45 Beaumé or an ordinary specific gravity of .8750 or .8000. These will give the following percentage of illuminating refined oil:

Beaumé.	Specific Gravity.	Per Cent. Oil.
30	.8750	30
45	.8000	75

The eastern oils have, we believe, from 40 to 44 Beaumé.

It is well then, for any one who thinks he has, or really has, oil signs on his land to consider these conditions and have the oil-show analyzed before he begins costly experiments. Oil must have a good paraffin base, not an asphaltic base, as quite a number have. It must be a light oil and not a heavy oil. Some heavy oils may carry a small percentage of good illuminating oil, which might be extracted from the crude, but the expense involved, with the amount of refuse material, is liable to eat up all profits from the refined.

BOOK REVIEW.

BULLETIN OF THE UNIVERSITY OF THE STATE OF MISSOURI, Columbia, Mo. Vol. 1, No. 3.

TRANSACTIONS OF THE NEW SOUTH WALES CHAMBER OF MINES, SYDNEY, N. S. W. Vol. 1, No. 2, May, 1900.

THE INDIKIL SYSTEM. A decimal system of weights and measures for the English speaking people, by A. Lincoln Hyde, Cleveland, O., 1900. 13 pages.

THE CRIPPLE CREEK VOLCANO, by T. A. Rickard. A paper read before the American Institute of Mining Engineers at the Washington meeting, February, 1900. 37 pages.

TWENTIETH ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATIONS OF THE LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE, FOR 1899, TO THE GOVERNOR, BATON ROUGE, LA.

BULLETIN NO. 3 ISSUED BY THE TERRITORIAL BUREAU OF IMMIGRATION FOR NEW MEXICO, ALBUQUERQUE, N. M. Pamphlet 23 pages. This pamphlet presents brief accounts of the principal mining regions of New Mexico.

BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION OF THE LOUISIANA STATE UNIVERSITY AND A. & M. COLLEGE, BATON ROUGE, LA. Second Series, No. 60. "Charbon, Further Investigation and Suggestions, with Summary and Conclusions."

PAPERS READ BEFORE THE INSTITUTION OF MINING AND METALLURGY AT THE GEOLOGICAL MUSEUM, S. W., JUNE 20TH, 1900. "On the Extraction of Gold from Auriferous Pyrites by Amalgamation," by Thos. G. Davey; "The Treatment of West Australian Sulphide Ores," by Alfred James; "Notes on Gold-Bearing Gravels," by W. S. Welton.

NUMEROUS IMPROVEMENTS were brought about by the activity of the Department of Mines during 1899 in connection with ventilation and similar problems which have become prominent in connection with the increasing depth of Australasian mines. Seven mines are now working in the Bendigo District, varying in depth from 3,000 to 3,424 feet.

CAHALL WATER-TUBE STEAM BOILERS, manufactured by Aultman & Taylor Machinery Co., Mansfield, Ohio. Although nominally a catalogue, this is another of those engineering textbooks for which the profession is indebted to the manufacturers, for in addition to the part which particularly describes the Cahall boilers there is much general information which will be found useful to all engineers.

PROCEEDINGS AND COLLECTIONS OF THE WYOMING HISTORICAL AND GEOLOGICAL SOCIETY, WILKES-BARRE, PA. Rev. Horace Hayden, Secretary. In addition to the strictly historical articles this report contains an interesting article on the Drift Mounds of the Susquehanna Valley and a catalogue of the Lacoe collection of fossils which are now deposited in the rooms of the Wyoming Historical and Geological Society.

PRODUCTION OF THE PRECIOUS STONES IN THE UNITED STATES IN 1899, by George F. Kunz. Extract from the 21st Annual Report of the United States Geological Survey, Washington, D. C. Pamphlet 48 pages. This report like all of the preceding ones by Mr. Kunz on this same subject is most complete and interesting and well worth the reading by any one interested in the mineral resources of the United States. Over one-third of the report is devoted to the discussion of the diamond, and another third

to corundum gems. The other gems are treated briefly. The value of the production of precious stones in the United States during 1899 was \$185,770. The growth of this industry is shown by the fact that in 1896 the value was \$97,850; 1897, \$130,675; and in 1898, \$160,720.

ANNUAL REPORT OF THE MINISTER OF MINES OF BRITISH COLUMBIA FOR THE YEAR 1899. 890 pages profusely illustrated. Published in Victoria, B. C. Price 50 cents. In addition to the general statistics of British Columbia this report contains detailed descriptions from the several sections, together with accounts of a number of well known mining properties. The typographical appearance of the book is most pleasing and British Columbia is to be congratulated upon so excellent a report setting forth the advantages and resources of her mineral products.

ANNUAL REPORT OF THE SECRETARY OF MINES AND WATER SUPPLY FOR VICTORIA, AUSTRALIA, FOR 1899. Melbourne, Australia. 78 pages. During the year the gold output in Victoria amounted to 854,500 oz., an increase of 17,243 oz. over the preceding year. The total production of Victoria to date amounts to 63,539,205 oz. valued at £254,156,820. The gold yield of the Australasian colonies during 1899 was 4,463,116 oz. worth £16,180,723. The increase in production since 1895 has been remarkable and amounts to 2,114,150 oz. Since the discovery of gold in 1851 the Australasian colonies have produced 110,413,597 oz. of gold valued at £427,194,079; 60% of which has come from Victoria. The best dividend paying mine in Victoria yields an average of 38 dwt. 11 gr. per ton, but a mine which yields one 1 dwt., 21 gr. pays dividends.

REVIEW OF THE AMERICAN STANDARD SPECIFICATIONS, Test Pieces, and Methods of Testing Iron and Steel adopted by Committee No. 1 of American Section of the International Association for Testing Material, by Albert Ladd Colby, South Bethlehem, Pa. Pamphlet 100 pages. A paper read before the International Association for Testing Materials, Paris, France. The full scope of the paper is given by the following chapter headings: (1) Review of the American standard specifications, test pieces, and methods of testing iron and steel; (2) The actual every-day practice of American steel works in determining the physical properties of iron and steel; (3) Methods in use in American steel works for the chemical analysis of steel; (4) Critical review of foreign specifications for steel rails; (5) Appendix containing the full text of the specifications for steel and wrought iron adopted by Committee No. 1, of the American Section of International Association for Testing Materials, May 1, 1900.

PERSONALS.

Mr. C. O. Brunner, treasurer of the Bethlehem Iron Company and Bethlehem Steel Company, completed on July 12th his fortieth year of service. The occasion was marked by the presentation to Mr. Brunner of a silver pitcher and salver and a handsome cane from his fellow members of the staff of the two companies.

The Naval Electric Company, with offices at 95 Liberty Street, New York City, has been organized to succeed the B. & H. Electric Company, of Dansville, N. Y., and New Haven, Conn. The same officers continue, the change in name being made as more appropriate for the distinctive line of electrical business in which the company proposes to engage. F. G. Hall, Jr., A. S. M. E., is the manager for the company, and I. E. Burdick, secretary and treasurer.

The Chicago Pneumatic Tool Company has engaged Mr. Fred. F. Bennett as sales agent and manager of advertising, with headquarters at the main office of the company, Monadnock Block, Chicago. Mr. Bennett, who resigned a position as sales agent for the American Steel Casting Company and American Coupler Company, of Chester, Pa., July 1, has had long experience in the journalistic field, has a wide railroad acquaintance, and has a thorough knowledge of trade publications.

Siberia's Mineral Resources.

Siberia produces one-tenth of the world's yield of gold, and but few of the mines have been worked, on account of the climate. The immense coal deposits have hardly been touched. One mine, with six beds, contains as much coal as all the deposits in England. The lack of transportation facilities alone has prevented it from being worked.

The Trans-Siberian Railroad, from an economic and a political standpoint, is the greatest work of this century. It gives Russia a superior standing in Pekin. It now touches the Amur; in three years it will reach Port Arthur, making the distance but thirteen or fourteen days from Moscow to Pekin.—U. S. Consular Reports.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Sulphide of Arsenic.

Editor Mines and Minerals:

SIR:—Will you kindly give me whatever information you can as to the uses and the amounts consumed of sulphide of arsenic (realgar). Kindly give me a list of the principal users and dealers in this mineral. Also please give me a list of the best work or works on the treatment of arsenic ores. Yours truly,
510 South L. St., Tacoma, Wash. F. H. WHITING.

Mensuration.

Editor Mines and Minerals:

SIR:—If a board is 12 ft. long and 12 inches wide at the big end and tapers from both sides to a point, I would like to know where it should be sawed across so as to have an equal amount of timber in each end. Yours, etc.,
Quincy Mine, Park City, Utah. I. C. HARRINGTON.

Locating Mineral Claims.

Editor Mines and Minerals:

SIR:—Will you kindly tell me whether mineral claims can be located in Minnesota, Michigan, Missouri, and the other Mississippi Valley States the same as in the Rocky Mountain States. If this cannot be done please state why this is so. Yours truly,
Red River, Minn. S. H.

The United States mining laws are not in force in any of the thirteen original States, nor in the States of Vermont, Tennessee, Michigan, Wisconsin, Minnesota, Missouri, Kansas, Alabama, Kentucky, or Texas, nor in Oklahoma or the Indian Territory. Valuable mineral deposits in lands belonging to the United States, in any of the States or Territories other than those above referred to are subject to disposal under the United States mining laws. It has been decided that a homestead entry would not be defeated by the discovery of a valuable deposit of mineral on the land covered thereby, provided the discovery was made subsequent to the issuance of the final certificate.

Monte Cristo District, Washington.

Editor Mines and Minerals:

SIR:—The Monte Cristo mining district, which is about to be reopened through the rebuilding of the Everett & Monte Cristo Railroad, will no doubt be of interest to many of our readers. This district was opened during the years of 1891-2, during which time the Rockefeller interests expended some five or six hundred thousand dollars in putting their properties here in shape to ship ore. In connection with their mines here they built the Everett & Monte Cristo Railroad, which connected their mines with their smelter at Everett, Wash. During a heavy mountain flood in 1897 the railroad was washed out and has remained so until the present time, but now the same is being rebuilt. Yours truly,
Monte Cristo, Wash. B. NORBERT OUMETTE.

Ventilating Air-Shaft.

Editor Mines and Minerals:

SIR:—A tunnel is 3,000 feet in length. Would an air shaft 1,400 feet from the mouth and 6 inches in diameter be large enough to ventilate it? Length of air shaft, 400 feet; formation of rock, gneiss. If the above would not be of sufficient size, how large should it be? Yours truly,
Idaho Springs, Col. JAMES UNDERHILL.

It is difficult to understand the meaning of this question. Does Mr. Underhill mean to ask if the ventilation of the tunnel can be accomplished by blowing air through a 6-inch bore hole? This can be done if the quantity of air required is small and an air pipe is used to conduct the air forward to the face of the tunnel where it is needed. It may be, however, that the reading "6 inches" is an error, and the question should be read

"6 feet" as the diameter of the air shaft. In this case, the ventilation of the tunnel is merely a matter of how much air is required, and the establishment of the ventilator that will supply this amount.

Gold Refiner's Problem.

Editor Mines and Minerals:

SIR:—Replying to Gold Refiner's problem in the March issue of MINES AND MINERALS.

Let d = difference in fineness between bullion to be added and fineness of bullion sought;

D = difference of bar in hand and fineness of bullion required, multiplied by weight of bar in hand;

W = weight of bullion to be added.

Then,
$$\frac{D}{d} = W.$$

According to problem, first part, $1,000 - 500 = d = 500.$

$32.3 (500 - 462) = D = 1,227.4.$ $\frac{1,227.4}{500} = 2.4548$ ounces, 1,000 fine to be added.

Second part, $900 - 500 = 400 = d.$ $32.3 (500 - 462) = 1,227.4 = D.$ $\frac{1,227.4}{400} = 3.0685$ ounces, 900 fine to be added.

Yours truly,
Nelson, B. C. A. L. McK.

Prospecting.

Editor Mines and Minerals:

SIR:—Will some prospector please give his experience regarding the following: While prospecting with pan on the hillside I obtained gold quite frequently near the base of the hill. In going higher the colors got smaller and fewer until finally I could get only a trace of gold. A few yards farther up the hill the formation changes from a highly ferruginous and decomposed slate to a more argillaceous and firmer variety. Between the two appear to lie several feet of a solid tough clay, which may be a decomposed porphyry. The soil is quite deep. There is little quartz attached to the gold. According to your experience would you expect a vein of some kind near this contact? Is it a general occurrence for gold to become less abundant near the outcrop of its source? If so, how do you account for this? Do you know of any veins of value having been found where the gold below their outcrop occurred only sparingly? I have spoken to others about this matter but have been unable to receive a satisfactory answer. Yours truly,
Covelo, Cal. PROSPECTOR.

It would not be unlikely that the porphyry itself might have the gold-bearing vein in contact with one side or the other of it, or that there might be one in its immediate vicinity, also the gold may be extremely "pockety" and hence require considerable search to find any of it in place. Concerning the occurrence of more gold near the base of the hill, this could be accounted for in some cases by the fact that as the talus or other material slid down the hill it would carry the gold with it. Subsequent erosion might wash and remove more material from the foot of the hill than from other points higher up, owing to the fact that the greater volume of water would be in motion at these places and at a greater velocity. This larger volume of water would disintegrate the talus, wash away the fine gold and much of the earthy matter, leaving only the coarse gold, while higher up the hill the fine gold may occur. It is impossible to give any more exact statement as all the facts are not fully stated, but I should first look for a vein near the porphyry, and, if not found, it would be well to then investigate the origin of the soil and try and determine whether it was of local origin or was composed of drift stuff brought from some distance.

Drainage and Pumping in Mines.

Editor Mines and Minerals:

SIR:—The article published in MINES AND MINERALS for May 1900 on "Drainage and Pumping in Mines," contains several good and useful suggestions. But from the standpoint of my little practical philosophy the latter part is erroneous and very misleading; especially so to the young student. I quote from the article as follows: "In determining the head of water under which the pump must work and against which it makes its discharge, it is customary to measure the vertical height from the pump to the point of discharge; the pressure due to the head of water is easily calculated by multiplying by .434." etc.

The above statement is certainly misleading as it costs the same mechanical labor and power per foot of vertical height from the pumping machine, to elevate water from its source or sump to the pump, as it does from the pump to the discharge point; consequently if an engineer should make a calculation according

to the quoted instructions on a pump for a twenty-five foot vertical height from source of water to pump, and twenty-five foot vertical lift from pump to point of discharge, he would find himself with half the necessary power to do the work.

Finding diverse opinions on the quoted statement, I referred it to the acknowledged authority on mine affairs in our district, and was told that the statement was correct; that the water comes to the pump from the sump on the principle of a siphon, and at no cost of power to the pumping machine. Again I referred it to two able and prominent candidates for the mine inspectorship, and for my trouble received some very uncomplimentary remarks about my knowledge of the textbook, etc., but after considerable discussion and pencil drawing, they agreed to look up the question. I also recollect a discussion carried on for several months in regard to this principle in the Correspondence pages of the Colliery Engineer about eight years ago, when I wrote a few lines which seemed to have closed the discussion; but I have been unable to find these few lines and would be obliged if you could refer to them and also give us some definite views on the question under consideration. Very truly yours,

Pittston, Pa.

D. W. E.

[We are glad to have our correspondent draw attention to the above. The reference to "the head of water under which the pump must work," as made in that article, was a general statement in which the pump was considered to be practically at the bottom of the lift, and the head under which the pump works is there spoken of, in a general way, as being the height from the pump to the point of discharge. Our correspondent is right, however, in saying that this height is the difference between the level of the water in the sump and the point of discharge, and the statement made in regard to the head of water should so read. It did not occur to us that there was any danger of some one's misunderstanding what was meant, or to what the head (*h*) was intended to refer, as we had in mind at the time, more particularly, a pump located at the bottom of a deep shaft and drawing its water from a sump practically at the level of the pump, which is true in regard to the location of mine pumps, in the majority of cases.

In regard to the question as to whether the vertical height from the level of the water in the sump to the pump, should be added to the height of the discharge above the pump, we would say it should by all means be so added. The effective head under which any pump acts, as previously stated, is the vertical height of the point of discharge above the level of the water in the sump. The pump elevates the water from the sump to the pump just as truly as it does from the pump to the point of discharge. The fact that a depression is caused behind the piston of the pump as it makes each stroke backward and forward, and that the atmospheric pressure acting upon the surface of the water in the sump, presses the water up the suction pipe and into the pump, does not alter the conditions as far as concerns the pressure head under which the pump works.

When the pump is located at the level of the sump and there is practically no suction head, the atmospheric pressure acts likewise upon the piston of the pump and the point of discharge, and the effective head is then simply the head of water-column from the pump to the point of discharge. If, however, the pump is located above the level of the water in the sump, the atmospheric pressure upon the piston of the pump is decreased by the suction head, and it is then very clear that the effective head under which the pump performs its work, is increased exactly by this amount, since the effective head upon the pump is the difference between the pressures upon the pump piston and the point of discharge. In locating the pump above the sump level we decrease the atmospheric pressure upon the pump piston and thereby increase the effective head upon the pump, and this increase is exactly the suction head.

There is no siphonage, in this case, whatever, and we think, perhaps, that our correspondent did not make himself clearly understood to the men to whom he referred his question. The discussion referred to by our correspondent arose from a question asked by "Beginner" in the Correspondence columns of The Colliery Engineer, Page 8, August, 1891, and continued in succeeding issues till the question was finally answered by our correspondent on Page 128, January, 1892.—Editor.]

Preparation of Anthracite.

Editor Mines and Minerals:

SIR:—There is a subject that, I think would be appreciated by all the anthracite mining boys, viz. the peripheral velocities of revolving breaker screens. In all my readings of the MINES AND MINERALS I have no recollection of ever seeing anything appear on this subject. I would therefore be indebted to you if you can find time to give us an article on this line, or if preferable to make some remarks upon the following formula, and numerous other facts that I have observed:

Let us take a two-circled screen, 5 and 7 feet diameters respectively, and perfectly horizontal, now let some coal drop into the bottom of the 5 ft. circle at *E* for a short interval, and then stop feeding. What velocity of periphery speed must the screen travel so that the coal at *E* will continue to go around with the jacket without falling back to the bottom center of the screen at *E*? We find that the force of gravity at the equator is equal to 16.1 ft. fall in one second of time, or, for the sake of our illustration with the 5 ft. screen we will say 16.2 ft., hence, when centrifugal force is equal to centripetal force (16.2) we have $g = \frac{C^2}{D}$, g being the power of gravity, D the diameter of the screen, and C the peripheral velocity per second.

To answer our question, then, taking the 5 ft. diameter screen, we have $\sqrt{16.2 \times 5} = 9$ ft. per second, for $gD = C^2$; this then is the velocity required with any material, when it cannot slide back, or down over the meshes to the bottom of the screen. If this is true, what should be the utmost peripheral velocity, so as to lift the coal to a certain distance, so that gravity may act upon it and draw it back down over the mesh to be rescreened.

Again, what relation is there, if any, between the peripheral velocity and the amount of pitch given to the screen? Take the 5 ft. and 7 ft. diameters as shown, should the velocity of the screen's periphery be made as high as to exceed the length of the chord of 90° *E F* and *C B*, or equal to the arcs *E G F* and *C D B*, or should it exceed the chord of 60° *E G* and *C D* and their arcs? The chord of 90° for a five foot diameter screen = $\sqrt{2.5^2 + 2.5^2} = 3.53$ ft., and the arc of said quadrant = $3.1416 \times 5 \div 4 = 3.93$ ft., and for a 7' diameter screen, the chord of 90° = $\sqrt{3.5^2 + 3.5^2} = 4.95$ feet, nearly, and the length of the arc = $3.1416 \times 7 \div 4 = 5.49$ ft. In observing the velocities of screens in various breakers that I have visited I find quite a difference, and especially so between old and new breakers.

The following are some screens that I know to give good satisfaction in sizing their coal: Here is a 7 ft. diameter screen running chestnut over mesh, and dropping through pea, buck, rice, and culm, and traveling at the rate of 5 ft. periphery speed per second, developing a centrifugal force of 3.57 ft. Another 8 ft. diameter screen has 5.82 ft. periphery speed and a centrifugal force of 4.23 ft. running stove over mesh and dropping through all smaller sizes. Another is 7 ft. diameter running egg over mesh and dropping smaller sizes through, making a velocity of 6 ft. per second and a centrifugal force of 4.50 ft. I know of a screen running pea over mesh that when the velocity was increased from 2.09 ft. to 3.6 ft. periphery speed per second, the quantity of coal passing through also measured about one-third and all well sized. If the pitch of this screen had been increased, instead of the velocity, would the result obtained be the same, and therefore, the greater the pitch the less the speed, and vice versa?

How many tons per hour would you estimate a 7 ft. diameter screen 20 ft. long could pass through, chestnut running over 1½ inch mesh, and all other sizes below dropping through? Pitch of above mentioned screens are all = ¾" per foot?

Yours truly,

W. D. OWENS.

Pittston, Pa.

[The questions raised by Mr. Owens are very interesting practical questions and we trust they will be taken up and discussed by those interested in the preparation of coal.—EDITOR.]

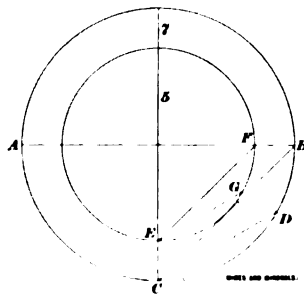
Mining Notes Regarding Tatepuzco, Acuitapilco, San Bartolo, etc.

Editor Mines and Minerals:

SIR:—There are in the dumps of the mines named Mine Grande, Tajitos, and Quezadeño, located in the mining district of Tatepuzco, Ahuacatlan, Tepic, more than 600 cargass of 138 kilos each, of ore averaging from 4 ounces to 5 per carga (30 oz. silver per ton). The ore is a concentrating ore, and a 3-stamp mill with a crusher and a concentrator can easily operate during seven months of the year with waterpower, and five by a steam 10 H. P. engine.

There is an old Hacienda de Beneficio (amalgamation process) which can be repaired with a thousand dollars Mexican. The total production of the ores may be calculated as 200 cargass of 138 kilos each, in the present conditions of the mines and hacienda, but the experts who have examined the properties say that the mines may become great producers and thousands of tons may be extracted from the old tunnels and shafts which are now caved in.

The mines of Tatepuzco are of a very great expectation and



only capital and an intelligent management are required to get millions of dollars from the working of such mineral.

The mines of Acuitapilco called El Mezquite, Trinidad, Catarina, and Buenavista, and Todos Santos were worked with success by the old Spaniards and later by miners from Guadalajara. Mr. Miguel Orendain, a native from Guadalajara, got a nice fortune by working the Mezquite in 1840. It is reported that the ore was so abundant that the miners working at that time day and night were not sufficient to reduce all the ore. The ruins and workings which for the present can easily be seen by visiting the place indicate the importance of the mines. One of these mines, the Valenciana, is being developed by an American company. A 3-stamp mill, a crusher, and a concentrator will soon be in place. For the present 50 men are employed at Acuitapilco. The high grade ore is being sent to the reduction works of Messrs. Lonergan & Stanhope, and the low grade ore is being reduced by the old patio process, with success, as good returns in gold and silver are being received by the company. Mr. J. S. Ickis has assumed the control of the working and a tunnel is open which facilitates the extraction of the ore. Ten tons daily is the present extraction of the pay mineral; the formation of the district is quartzite and porphyry. Rich streaks have been encountered assaying from 600 to 3500 ounces per ton of 2000 pounds.

The owners of the mines have later acquired the rights to two waterfalls which operate the six old tahonas used in the reduction of the ores, but as the Valenciana Company will soon erect a reduction plant, the reduction of the ores will be made, giving good profits to the proprietors. The level ground is sufficient for the erection of a large reduction plant, and the waterpower is also sufficient to operate any class of machinery.

The San Bartolo mines are situated to the southeast of the City of Tepic, 15 miles distant, and 60 kilometers from the San Blas seaport on the Pacific coast. The veins are so wide that any amount of low grade gold ore, free gold and concentrating, can be had in sight. Water power can be easily had close to the mines; timber and hardwoods can be had at a very cheap price. The average of the ore is 30 ounces silver to the ton of 2000 lbs., and 10 ounces gold. The erection of a large reduction plant with many concentrators is the best investment here in this district.

On the south of San Bartolo are situated the mines of Guadalupe and San Juan; the first mine has a rich streak the ore averaging 300 oz. silver per ton and 3 oz. gold. The San Juan has any amount of low grade gold and silver ore. The present owners have ten men constantly at work exploring the district; rich stringers cross the vein and it has a width of two meters. The old mines, the celebrated mines of the Countess of Miravalles were worked by the Spaniards and millions of dollars were sent to Spain by Muño de Guzman and successors. The immense fortune of the Countess of Miravalles was made by the working of her mines. For the present the best mine, named La Concesa; has been located and a company is to be organized with the end of exploring this rich region. The Pacific States Mining and Investment Co., of San Francisco, California, will soon organize a new company with the object of exploring Tepic.

Yours, etc.,
TEPIC.

Kentucky Zinc, Lead, and Fluorspar District.

Editor Mines and Minerals:

SIR:—Much has been said of late of the remarkably rich deposits of zinc, lead, and fluorspar, as found in Livingston and Crittenden Counties, Kentucky. These deposits are found in true fissure veins, identical with those of the leading mines of the Old World and much different from those so far opened up in the United States, namely the Kansas-Missouri district, where the minerals zinc and lead are found in pockets or blankets in the limestone and where one hundred tons of rock must be removed to obtain 6 tons of zinc, for the average for the entire Kansas-Missouri district is about 6%.

The new southwestern Kentucky district has already shown such wonderful developments in zinc, lead, and fluorspar as to surprise all operators. This district, which six months ago was comparatively unknown, has in such a short period developed over two dozen producing mines; there are ten or twelve companies in the field and new ones coming daily.

The minerals as found are extraordinary from the fact that the entire vein matter is a combination of the three minerals, namely, zinc, lead, and fluorspar. In the separation of same there is about 10% of loss; the average value per ton for every ton mined is over \$22.00.

The zinc produced in this district is of a high grade assaying from 62% to 65½% metallic zinc and less than 1% iron. The lead is only equaled by that of the St. Francois district. The fluorspar as produced in this district is the only fluorspar ever found in the United States and the richest ever found in the known world; it assays from 95% to 99.86% fluoride of calcium, that of England and Germany rarely reaches 45% fluoride of calcium.

There have been some 12 or 15 of these true fissure veins opened up to date; they are well defined, having been traced from 5 to 20 miles, and are from 3 to 40 ft. wide; the depth has never been ascertained, there apparently being no bottom.

This southwestern district has many advantages over all others it being well supplied with waterways and railroads, and near the market centers. This district has proven a revelation, the supposition being that no district in the United States could ever equal those of Belgium, Spain, Italy, Wales and England for the reason they had the true fissure veins, but now Kentucky comes to the front with the same mineral formation and in addition has the fluorspar which will prove an important factor. Heretofore all the fluorspar used in the United States, amounting to millions of dollars, has been imported. The greatest portion is yet imported, developments in the southwestern Kentucky district not having reached that point where it can supply the great demand which is constantly increasing.

A very fair illustration of the progress made in this district can be drawn from the following: The Bonanza mine in sinking a shaft to 75 ft. removed 450 tons of fluorspar assaying 99.85% fluoride of calcium the richest known mine of its kind in the world.

The Morning Star mine in sinking shaft to 70 ft. removed lead and fluorspar both of superior quality from within 5 feet of surface to present depth. The Evening Star, joining the Morning Star, at 78 ft. has gone through 45 ft. of solid mineral vein which is 35 ft. wide. They have enough ore to run their mill, which works the dry process, for many years. This mill has only two duplicates in the United States.

The Columbia mine at 150 ft. has four drifts run all in the finest kind of ore. There is a mill and smelter on the property. The Hodge mine has shipped 8,000,000 lb. in eight months' work. The Rose Clare mine at 240 ft. has 2 drifts run 230 and 400 feet respectively, daily shipments of 45 tons, a fully equipped concentration mill and all improved machinery.

The Memphis, Yondale, and Tabb with mill located at Marion, Ky., on Illinois Central R. R., has 4,000 tons on dump and is making daily shipments. The Holly, La Rue, Pansy Blossom, Sweet Marie, Babb, Guill, Milner, Cox and others are in good ore.

A remarkable feature of this district is the progress made by those working. Some there are, of course, working day and night; but the results in such a short time are wonderful.

Salem, Livingston Co., Kentucky, is the center of operations. The Cumberland River is on the south and the Ohio River on the north and west, while the Illinois Central R. R. traverses the district. With mines producing mineral assaying 20% to 42% zinc, 18% to 25% lead, 30% to 50% fluorspar, and less than 10% waste in separation it is not hard to prophesy a brilliant future for the southwestern Kentucky district.

Yours, etc., E. LANGENBACK,
Vice-Prest. Berger Mfg. Co.

Canton, Ohio, July 10, 1900.

Arizona Notes.

Editor Mines and Minerals:

SIR:—Continued and increasing activity in mining seems to be the order of the day, in Arizona at least. The Little Meadows find several weeks ago has been succeeded by the opening up in the Redemptus mine near the Rainbow Group, in the Hualapai district, of a large body of rich silver ore with every prospect of its continuation. I looked this property over last fall and encouraged the owners to push the work in the tunnel in which the discovery was made in preference to sinking a winze as they contemplated. Mr. Furguson and his sons are to be congratulated; they are hardy prospectors and deserving of all they may find.

Having been called to Los Angeles on business connected with the putting in of a large plant of machinery I have taken some considerable pains to look up what might be new in the line of machinery for the economical handling of ores. In that line I found two appliances, a crusher and a muller, which deserve attention. The crusher consists essentially of a vertical plunger working in vertical ways in proximity to a stationary crushing face, which is substantially parallel with the face of the plunger at the lower end, throughout a considerable extent, and diverges from the face of the plunger at the upper portion. The plunger is adjustable from and toward the fixed jaw, in order to gauge the opening through which the crushed material will be discharged, thereby regulating the size of the crushed material. The inventor of this crusher and muller is Henry B. Case and the advantages presented to my mind by this machine are: (1) The rock is broken by chipping instead of by pinching, so that the body of the pieces of ore does not have to be crushed, but is broken around the corners and edges, and the portions thus broken away fall into a constantly narrowing space, to be again broken in like manner, and so on, until the material reaches the

narrowest space. (2) The material immediately before its discharge, has to pass through a long passage, the space between the walls of same being accurately gauged, so that the finished product is practically of a uniform size. Tests which have been made show that when the machine is set to crush to a 40 mesh size, the percentages of different ores run from 20% to 52% between the 40 and 60 mesh, showing that the percentage of slimes would be much less than is usually obtained. (3) The pulverized particles do not remain with the unpulverized material in the crusher, but immediately pass out of the discharge opening, thus preventing further pulverization when the particles have been brought to the proper size. (4) The final process of pulverization is accomplished by a rubbing motion between the two flat surfaces, so that the particles of free gold or other metals contained in the ore, are not pulverized or flattened, but are rolled into wire form, and are therefore more readily collected. The capacity and speed, from the experiments which have been made, indicate that a larger quantity of rock can be pulverized with less power than with other crushers.

The most economical plant will consist of a number of machines, the largest of which will come first and each of the other sizes following, each one being set on a lower level, and connected by a conveyor provided with the proper screens until the last one is reached and the final sizes made. The saving in original cost over stamps and other heavy crushers, and reduction in cost of transportation by reason of reduced weight will be carefully considered by mining men.

The "Telegraph" Group in Greenwood district will in the near future probably change hands and within 90 days thereafter a large cyanide plant will be at work upon the ore, of which there is by actual measurement over 260,000 tons in sight above the surface of the ground that will net the new owners from \$9.00 to \$12.00 per ton. In my next I hope to have something of especial interest to machinery men and investors in mines. Our new railroad which will pass through this section is making good progress with the grading and the surveyors have now reached the junction of Boulder and Burro Creeks.

Yours, etc.,

W. A. MENSCH.

Signal, Mohave Co., Ariz.

Taylor-White Tool Steel.

Of the many remarkable industrial developments in the United States during the past two decades none is more striking than the development of the manufacture of armor plate and heavy forgings. Fifteen years ago no work of this kind was done in the United States, but within that time new plants have been completed and the process of armor plate manufacture and the work of heavy forging have been so perfected that American firms now enter the European market and are able to compete with and secure work in opposition to European firms which have been long established.

In this development the Bethlehem Steel Co. has been particularly prominent and it has gradually developed a plant which is one of the most interesting in the world. Several years ago it was found that, although the company already had the longest machine shop in the world (more than $\frac{1}{2}$ of a mile in length), this shop could not handle all of the work being turned out by its other departments. Before building another machine shop, which would have meant an expenditure of at least a million dollars, it was decided to reorganize the shop methods which were prevailing at the time.

In the reorganization of the shop method Mr. F. W. Taylor, the well known expert in shop organization, found several changes necessary, the most important of which was the discontinuance of the miscellaneous assortment of tool steels used by the different men in the shop, and the establishment of a standard and uniform grade of tool steel, the use of which would be enforced upon all of the men regardless of their preferences.

A special lathe was set aside for the purpose of experimenting with all brands of tool steels, and under the direction of Mr. Taylor and Mr. Maunsel White, Engineer of Tests of the Bethlehem Steel Co., over 200 tons of steel forgings were cut up into turnings. Out of this exhaustive investigation there was gradually evolved, after an expenditure of over \$100,000 in labor and material alone, the "Taylor-White process." The details of this process have not yet been made public as the patents are still pending, but it is understood to be a special heat treatment of a peculiar brand of self-hardening tool steel. Although large sums have been spent in developing the apparatus, the appliances for carrying on the process as now used are said to be extremely simple and to cost only \$600. It is automatic in action so that it does not require skilled labor in carrying it out. The process is applied after the tool has been dressed to shape and the effects of the treatment penetrate throughout the steel and are not simply on the surface. The process has been applied to a number of standard tool steels

and the efficiency of a Mushet tool steel can be increased 25%, but the best results are obtained from a special composition of steel.

The Taylor-White process steel has the valuable and exceptional quality of retaining a high degree of hardness at a red heat and it is possible with tools made of it to cut at a speed great enough to heat the point of the tool to redness. Cutting with a tool thus heated leaves an unusually smooth finish on the work, thus greatly decreasing the work of finishing. This special steel forges readily so that tools of difficult and irregular shapes can be made from it. A simple, rapid method of annealing the steel has also been found by which tools may be easily machined to shape, making it applicable to twist drills, chasers, inserted cutters, etc., heretofore never made from self-hardening steel. Owing to the automatic feature of the process the steel obtained is very uniform in product and the variation in quality of the tools is said to be not over 5%.

The Taylor-White tools can be run from 2 to 4 times as fast as any other tools on the market. A great advantage in the use of these tools is that when cutting dry at the rate of maximum efficiency the chips should come off blue, these blue chips enable a foreman at a glance to tell whether the work is being done at the proper speed. When running under water at the proper cutting speed the chips should show blue immediately upon shutting off the water and allowing the tool to cut dry for a few moments.

The Bethlehem Steel Co. through its introduction of this tool steel into its machine shop has completely solved the problem which it undertook two years ago and now the capacity of the forge has to be greatly increased to keep pace with the growing efficiency of the machine shop in which the speed of the main line shafting has been increased from the former speed of 90 revolutions per minute to 250 revolutions per minute. Further changes in counter shafts have greatly increased the efficiency of the machine shop by the speeding up of individual machines. The increased efficiency of this machine shop due to the use of the Taylor-White process is shown by the following table:

Average.	Oct. 25, '98.	May 11, '99.	Jan. 15, '00.	Gain in % cut of 3d over 2d.	Gain in % cut of 3d over 1st.
Cutting speed	8' 11"	21' 9"	25' 3"	16%	183%
Depth of cut	.23"	.278"	.30"	8%	30%
Feed	.07"	.0657"	.087"	32%	24%
Pounds of metal removed per hour	31.18	81.52	137.3	68%	340%

A very interesting exhibition of the use of this steel was given Tuesday, July 30th, in which the following striking tests were made. In each of the tests made the cut was 3-16 of an inch on a side.

A high carbon steel shaft was placed in the lathe and revolved at a speed of 15 ft. per minute. After 20 minutes of cutting the Taylor-White tool was found to be only slightly nicked, while a high grade Mushet tool working under the same conditions was so dulled in 25 seconds that it would not take hold of the metal at all.

In the second test, an old roll made of hard cast iron was put into the lathe and after 20 minutes of cutting the Taylor-White tool was in perfectly good condition, while under similar conditions of operation a Mushet tool was completely worn out in 22 seconds.

The third test was of ordinary merchant steel with the lathe running at 150 ft. per minute. The Taylor-White tool steel although quickly heated to redness continued to cut, and at the end of the test lasting 4 minutes the cutting edge was still in good condition. The edge of a Mushet tool steel was burnt off short in 5 seconds. Exhibits were also given of the use of this tool steel in connection with heavy cuts at fast speeds in planer work, in forgings, and in the making of armor plate bolts.

The tool room of the machine shop of the Bethlehem Steel Co. is the best evidence of its faith in the results of the long and costly series of experiments which have been made with this steel. This room was entirely fitted up with new process tools from the planer in form to the most intricate and representing the expenditure of a large sum of money.

The Bethlehem Steel Co. will undertake in its shop any experiments to satisfy interested parties of the value of these tools. The experimental test lathe can be run at speed from 2 to 300 revolutions per minute, and will take work up to 60 inches in diameter. It is driven by an independent 40 H. P. motor giving ample power for any desired test. The Company also has on hand forgings and castings in steel and iron varying in hardness from the hardest tool steel to the softest merchant steel.

The shop right to use the Taylor-White process is being sold, the price being based upon the number of machines as well as their size and character. Many machine shop representatives have visited the shop of the Bethlehem Steel Co. to investigate the process, and already a number of foreign concerns have looked into the matter and are negotiating for its introduction abroad.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for September.

QUES. 612.—*Haulage, Load Upon Guide Sheaves*.—Calculate the load upon the journals of each guide sheave around a curve in a haulage road. The radius of the curve at the center line of track is 48 feet, and the sheaves are set 26 inches from track center, and 4 feet apart, center to center. The tension upon the rope is 6 tons.

QUES. 613.—*Timbering, Size of Collar*.—In the timbering of the airways of a certain mine, if we use round timber and the depth or diameter of the collars is 8 inches in an airway 8 feet wide, what should be the depth of the collars when the width of the airway is 14 feet?

QUES. 614.—*Timbering, Relation of Diameter to Length of Post*.—How should the diameter of prop timber vary with respect to the length of the prop or thickness of the seam? In timbering a certain mine, if 5-foot props are used in the rooms, and these props have a minimum diameter of 6 inches, what should be the minimum diameter for posts set upon the roads in this mine, when the roadway props have a length of 8 feet?

QUES. 615.—*Hoisting, Size of Engine*.—Calculate the size of a duplex second-motion engine geared 1 to 3, the ratio of length of stroke to diameter of cylinder being 1.25, that will hoist a maximum output of 1,000 tons per day, from a double compartment shaft 800 feet deep. The weight of the cages is 2,200 pounds each and the weight and capacity of mine cars is 1,400 pounds and 2,000 pounds, respectively. The length of a working day is 8 hours. Allow $\frac{1}{8}$ of the total moving load for friction, and estimate upon the engine as having an efficiency of 60%; the engine to cut off at $\frac{3}{4}$ stroke, the boiler pressure being 90 pounds per square inch. No balance rope is used beneath the cages.

QUES. 616.—*Tail-Rope Haulage*.—The haulage in a certain mine is to be accomplished by the tail-rope system. The distance from the tail sheave to the shaft bottom is 1,500 yards, and the shaft is 350 yards in depth, the engine being located upon the surface at the mouth of the shaft. The seam is generally flat, but there are up and down grades in the haulage road, the steepest being a 10%-grade in favor of the empties. Calculate the size of rope and the effective horsepower required for this haulage, assuming an output of 900 tons in 10 hours, the weight and capacity of the mine cars being 1,200 and 1,800 pounds respectively.

QUES. 617.—*Safety Valve*.—The distance from the fulcrum to the stem of a safety valve is 5 inches, the diameter of the valve seat $2\frac{1}{2}$ inches, the weight of the lever 15 pounds, and its center of gravity 10 inches from the fulcrum. If the ball weighs 75 pounds, how far should it be set from the fulcrum, in order that the valve will blow off at a boiler pressure of 90 pounds per square inch?

QUES. 618.—*Energy of Fly Wheel*.—The fly wheel of an engine measures 6 feet in diameter, out to out, and 8 inches on the face, the thickness of the rim being 3 inches. If this wheel is set upon

the crank shaft of a $12'' \times 16''$ engine, at what speed will the stored energy of the wheel equal the power of the engine, assuming a mean effective cylinder pressure of 50 pounds per square inch?

QUES. 619.—*Ventilation, Splitting Air Currents, Power Constant*.—The ventilation of a certain mine is accomplished by means of a fan running at a speed of 150 revolutions per minute. The maximum power of the engine is being employed, but the quantity of the air in circulation is not sufficient to meet the requirements. If it were possible, in this mine, to divide the ventilating current into two equal splits, still retaining the same power of the ventilator, would the quantity of air in circulation be doubled by this means? If you say No, please explain why.

Answers to Questions Which Appeared in the July and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 582.—(a) What rule determines the depth to which holes should be drilled in a breast of coal, in blasting? (b) What conditions determine the size or grade of powder, and amount of charge, in blasting coal? (c) State how you would proceed in mining and blasting coal, under the following conditions: The seam is a 5-foot seam of bituminous coal somewhat soft, and inclined to "seam out," in blasting; the roof is a hard sand-rock; under the coal is a 5-inch seam of good mining clay. State in detail the diameter, position, and direction of drill holes, grade of powder, and weight of charge you would employ.

ANS.—(a) The rule for drilling holes is that the depth of the hole should not exceed the line of least resistance. [The depth of the hole is also influenced indirectly by the thickness of the seam, since the line of least resistance is usually proportionate to the size of the shot or width of the heel, which practice makes proportional to the thickness of the seam.] (b) The nature of the coal as to its hardness or softness [also the character of the work—room work, pillar work, or "shooting off the solid"] determine the size or grade of powder. The width of the shot, and its adhesive nature, diameter of hole and thickness of seam, the character of the coal with respect to cleavage and cleats, all of these determine practically the amount of the charge. (c) As the shots in this case incline to seam out in blasting and the roof is a hard sandstone, the best way to work the coal would probably be as follows: Start the holes low or near the floor and incline them upward towards the roof. Drill holes of $2\frac{1}{2}$ inches in diameter. As the coal is soft the powder should be a large grained or slow powder. The weight of the charge would vary according to the thickness of the shot to be fired. The weight of the charge of powder is got by the following rule: Multiply the fourth power of the distance in feet from the center of the charge out in the direction of the line of least resistance by .4 of the diameter of the hole in inches, and divide the result by the thickness of the seam in inches. The result will be the weight of the charge in pounds. WM. CHAMBERS, Spaulding, Ill.

Second Prize.—M. Fagan, Pana, Ill.

QUES. 596.—*Retrograde and Direct Verniers*.—Explain the difference between the retrograde and direct vernier, and state how you would determine to which class a certain vernier belonged. Show a vernier of each kind and explain how it is read.

The difference between a direct and a retrograde vernier consists in the manner in which they are graduated. The terms direct and retrograde refer to the manner in which the vernier of each respective class is read. To determine to which of these two classes a

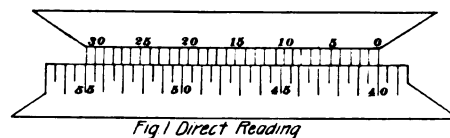


Fig. 1 Direct Reading

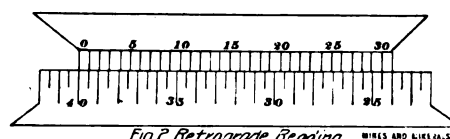


Fig. 2 Retrograde Reading.

vernier belongs, it is only necessary to determine the number of divisions of the main scale that correspond to the divisions on the vernier scale. Thus, if n number of divisions on the vernier scale equals $n - 1$ divisions of the main scale, the vernier is called direct; but if n number of divisions on the vernier scale equals $n + 1$ divisions of the main scale, the vernier is called retrograde.

[The divisions of the main scale always equal some unit of

length or of angular measure, foot, inch, centimeter, degree, half-degree, etc. Then, the number of parts into which this unit of the main scale is to be divided determines the number (n) of divisions of the vernier scale. Thus, a rod reading to thousandths of a foot usually has its main scale divided into feet and hundredths of a foot, and the length of its vernier scale is then made equal to 9 of these divisions, if *direct*, or 11 divisions if *retrograde*; but in each case, the vernier would have 10 divisions.]

To read a direct vernier, suppose the zero line of the vernier to coincide with some even division of the main scale, Fig. 1, [and suppose the main scale to be divided into half-degrees (30 min.), if the instrument reads to minutes, the vernier has 30 divisions, and these] 30 divisions of the vernier scale equal 29 divisions on the main scale and each vernier division equals $\frac{1}{30}$ of a scale division or 29 minutes, one minute less than a division of the main scale. Now, if the vernier is moved forward 1 minute, the first line of the vernier scale from zero in the direction in which the vernier was moved will be in coincidence with the main scale. If moved 2 minutes, the second line will coincide, and so on to the end of the vernier scale. Such a vernier is called a *direct vernier*. To obtain the total reading the main scale is read from zero to the zero of the vernier, and then the vernier scale is read forward in the same direction to its line of coincidence; thus, in this case, degrees and half-degrees (30 min.) are read from the main scale, but minutes less than 30 are read from the vernier and added to the first reading.

If the vernier is retrograde, (Fig. 2) the 30 divisions of the vernier scale will equal 31 divisions of the main scale instead of 29 as before. When the vernier is moved forward one minute, the first line of the vernier back of the zero point will be in coincidence on the main scale, and so on. Such a vernier is called a *retrograde vernier*. To obtain the total reading of this vernier, the main scale is read, as before, from zero to the zero of the vernier, and then the vernier scale is read from here backward to the line of coincidence, or in the opposite direction from the reading of the main scale.

W. F. HUGHES, Plymouth, Penna.

Second Prize.—HOWARD R. STEWART, Columbia University, N. Y. City.

QUES. 597.—*The Use of Wet Steam.*—What disadvantage arises in the use of wet steam, in the operation of hoisting and winding engines? Describe some efficient means at hand that will remedy this evil.

Ans.—In short-stroke high-speed engines, such as are usually employed for hoisting and winding, sharp cut-offs and small clearances are the rule nowadays. This has introduced an element of danger from water in the cylinder (the result of wet steam). A water ram is produced by the swift moving piston driving this water of condensation into the small clearance provided. This is apt to cause the wreckage of the engine by forcing out the cylinder heads and damaging the working parts.

With wet steam high efficiency can never be obtained. Outside of the liability to engine break-downs, which must be guarded against by reducing the speed of the engine, which is equivalent to a reduction of power, is the absolute reduction of work done, due to the moisture in the steam and there is the further danger of cutting the edges of valves and ports, which is not only injurious to the engine, but causes leakage and improper distribution of steam, making the expense of operation far greater than it should be with steam perfectly dry. With wet steam proper lubrication is not obtained, on account of the water destroying the action of the oil in the cylinder and valves, when cutting results. The engine is then practically in the same condition as if no oil had been used.

To overcome these evils numerous devices have been invented and applied. Relief valves, explosion diaphragms, drip-cocks, etc. are often applied direct to the cylinder, and are found effectual within the limits of their possibilities. These are, however, inadequate to remove the danger of breakage arising from the presence of water which comes into the cylinder in large quantity from undrained pipes, sudden boiler foaming, and other like causes. The most efficient means to avoid such danger is to introduce a "steam separator" between the steam supply and the cylinder, and to place it as near to the steam intake as practicable.

There are several separators in the market, of more or less merit. The most approved patterns are based on the principle that if a rotative motion is imparted to the steam in the separator, the liquid particles contained being heavier than the steam, are projected to the outside of the current against the outer shell of the apparatus, by centrifugal force, whence they flow in a thin sheet into a receptacle below. The steam, then, in a dry condition, passes out of the separator and is conducted into the steam chest of the engine without the stream of separated water.

THEODORE SIMONS, Roseland, B. C.

Second Prize.—CHAS. E. BOWRON, Birmingham, Ala.

QUES. 598.—*Essential Factors of Ventilation.*—Mention the

essential points in the ventilation of a coal mine, and describe the practical importance of each point named.

Ans.—The efficient or thorough ventilation of a mine is dependent upon three essential elements: (a) Volume of the current; (b) Manner of conducting the current through the mine; (c) Velocity of the current.

(a) *Volume of Air Required.*—The quantity of air required to be furnished per minute to the workings of a mine is usually fixed by the law of the state or country in which the mine is located. The amount specified is usually, in non-gaseous mines, 100 cubic feet per minute per man, and five times that amount per minute per mule or horse. In gaseous mines this amount is increased to 150 cubic feet per minute per man, and in some cases, as in the anthracite mines of Pennsylvania, 200 cubic feet per minute per man are required by law. This method of fixing the amount of air required is purely arbitrary, and often not adapted to the existing conditions, as the workings in a thin seam may have an abundance of air which may result in producing too high a velocity; while in a thicker seam the resulting velocity will perhaps be too low for proper ventilation.

(b) *Manner of Conducting the Current.*—The thorough ventilation of the working face in any mine is dependent to a large extent upon the manner in which the doors, stoppings, brattices, overcasts, or bridges are erected. These should not be allowed to leak.

Doors should be hung with a fall sufficient to close behind a passing car, and should be fitted tightly to a substantial frame. Where the ventilating pressure is light, a door is sometimes hung to swing both ways, to save trapping. Ordinarily, however, this cannot be done and the door must then be hung to open against the current. Canvas flaps are sometimes nailed to the bottom of a door to prevent leakage and allow of good clearance for the door. Double doors are sometimes used in cross-cuts near the shaft bottom, between the main airway and the return. The object of double doors is to prevent the momentary stoppage of the ventilating current when a car is passing through the cross-cut. The doors are set from 6 to 8 yards apart, or farther, if the length of the cross-cut will permit. Stoppings are commonly built of a double wall of slate with a few inches of space between. This space is filled completely to the roof with fine sand or clay from the surface; or fine dirt taken from the roads may be used. Stoppings upon the main air-courses of large mines are often laid up with brick instead of slate and the walls plastered with fire clay. Brattices are partitions, usually of wood or canvas (brattice-cloth), for the purpose of dividing the airway for a short distance near the face into an intake and a return. Curtains are heavy canvas hung across an airway or at the mouth of a room to partially turn the air. A curtain serves as a regulator, inasmuch as it permits a portion of the air current to pass it, while the remaining portion is forced into another passageway. Regulators are contrivances for regulating the division of air between two or more airways. Bridges (overcasts or undercasts) are built in airways for the purpose of crossing the air currents. All of these means for conducting the air current through the mine are of practical importance because efficient ventilation is dependent upon their use.

(c) *Velocity of the Current.*—This is a very important factor in the ventilation of a mine, as upon it largely depends the removal of mine gases. A body of firedamp or of marsh gas which is exuding from the coal, or has collected in some cavity of the roof, or at the face of some rise heading, will require a current having a certain velocity to dilute it and drive it from its position. In like manner the heavier gases, as carbonic acid gas, which settles in the dip workings and low places of the mine cannot be carried out if the velocity is too low. The current velocity should not be allowed to fall below 3 or 4 feet per second at the working faces. On the other hand, too high a velocity of the ventilating current is always objectionable, and, in gaseous mines, dangerous. The anthracite mine law of Pennsylvania provides that all air passages shall be of a sufficient area to allow the passing of 200 cubic feet per minute per man at a velocity not exceeding 450 feet per minute, and this velocity may be taken as a safe maximum limit in gaseous mines. It must be remembered that a safety lamp carried against a current is virtually subjected to a velocity equal to that of the current plus the velocity with which the lamp is being carried against the current. In non-gaseous mines the velocity of the main inlet may be anywhere from 10 to 20 feet per second which may not cause serious annoyance, and in many cases it exceeds this amount; but it should not fall below 3 or 4 feet per second in any airway in the mine.

JOHN COWAN, Antrim, Penna.

Second Prize.—THOMAS CHARLTON, West Leisenring, Penna.

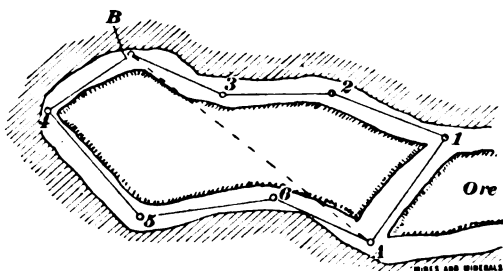
QUES. 599.—*Extending a Mine Survey.*—In extending a previous survey in a mine, explain in what manner you would proceed, if you could find but two points of the old survey remaining in the mine, and these points were not consecutive points, or not upon

the same entry. Explain, in general, what method you consider the safest to employ in the connecting of two mine surveys underground.

Ans.—Let A and B in the figure be the two points remaining of the old survey, and whose latitudes and departures are known, referred to the meridian or base line to which all mine surveys are connected. By means of the latitude and departure method the bearing and length of the line $A-B$ may be calculated. Thus, calling the difference of latitude between A and B , x , and their difference of departure y , the bearing of the line $A-B$, a , and its length L , we have,

$$\tan a = \frac{y}{x}, \text{ and } L = \sqrt{x^2 + y^2}, \text{ or } \frac{x}{\cos a}, \text{ or } \frac{y}{\sin a}.$$

Use the old points A and B as stations of the new survey $A-1-2-3-B$. Assume any convenient approximate meridian and calculate by the latitude and departure method as shown above the bearing and length of the line $A-B$ from the notes of the new survey, referred to this approximate meridian. Where possible the survey should be extended from B around to A again, by means of stations 4, 5 and 6, as shown in the figure, and the calculation of the bearing and length of $A-B$ checked, and if an error is found, it can be corrected. Since the true bearing of the line $A-B$ is known from the first calculation from the



notes of the old survey, we correct each course of the new survey and the assumed meridian by swinging these to the right or left until the course $A-B$ corresponds to the true bearing of the line. The difference between the true bearing of $A-B$ and the bearing found by the new survey will be the correction to apply to all the courses $A-1$, $1-2$, $2-3$, $3-B$, $B-4$, $4-5$, $5-6$ and $6-A$. Now from any of these lines the mine surveys can be extended to any part of the mine.

When a mine is connected by two shafts or shaft and a slope, the safest way to connect underground surveys would be to extend from the meridian or base line a survey down each shaft or slope, and extend them until they meet at a common point. Then by the latitude and departure method errors can be found and corrected and the survey balanced. In metal mines where the only other connection between levels, besides a shaft, is by raises extending from level to level and from upper level to surface, the quickest and surest method is by connecting the surveys on each by running another survey between the levels through these raises, and following same method of calculating survey to balance it.

[In general, the safest way to connect two surveys, or to extend an old survey is to make two points at least common to the two surveys and calculate the bearing and length of the line joining these points. Use this line as a base line for connecting the two surveys. The length of this base, as calculated from the notes of each respective survey should be the same. The difference between the respective bearings of the line shows the correction of bearing which must be applied to each course in one or the other of the two surveys in order that they shall agree. The farther apart the two points can be taken, or the longer the connecting base line, the better the results obtained.]

F. R. ABRE, Soudan, Minn.

Second Prize.—W. F. HUGHES, Plymouth, Penna.

Ques. 600.—*Engine-Plane Haulage*.—Calculate the size of rope, drum, and engine required for an output of 1,000 tons per day of 10 hours, at a slope mine, when the inclination of the slope is 30° , and its length measured upon the incline is 500 yards. Assume the capacity and weight of mine cars as 2,000 pounds and 1,200 pounds respectively. Estimate the rolling friction as $\frac{1}{10}$ of the normal pressure upon the plane. Assume a mean effective cylinder pressure of 80 pounds per square inch, and a speed of winding of 750 feet per minute, allowing 60 per cent. for the efficiency of the engine.

Ans.—Assume that the double-track system is used. Then $500 \times 3 = 1,500$ feet of winding per trip. Say it takes 4 minutes to change the ropes at the top and bottom each trip; then

a trip will be landed each $4 + 2 = 6$ minutes; and since the capacity of the mine cars is 2,000 pounds = 1 ton, we have,

$$\frac{1,000 \times 6}{10 \times 60 \times 1} = 10 \text{ cars per trip;}$$

and $10(2,000 + 1,200) = 32,000$ pounds, weight of loaded trip.

Let W = weight of ascending or loaded trip (pounds);

w = weight of rope per linear foot (pounds);

l = length of slope measured on the pitch (feet);

a = angle of inclination of slope;

T = maximum pull or load upon the rope (pounds).

The pull or load upon the rope, in this case, is the sum of the gravity pull and friction pull, and is a maximum when the last car of the trip has just left the "dish" at the foot of the slope.

We have $(W + wl) \sin a$ = gravity pull,

and $(W + wl) \frac{\cos a}{40}$ = friction pull;

hence,

$$T = (W + wl) \times \left(\sin a + \frac{\cos a}{40} \right) = \text{maximum load on rope.}$$

Size of Rope Required.—Substituting given values in the above equation and assuming an approximate value for w , of say 3 pounds, we obtain

$$T = (32,000 + 3 \times 1,500) \left(.5 + \frac{.866}{40} \right) = 19,040 \text{ lb., say } 19,000 \text{ lb.}$$

Multiplying this by 2 to provide against shock, and using a factor of safety of 6, we find the breaking load of the rope should be

$$\frac{19,000 \times 2 \times 6}{2,000} = 114 \text{ tons.}$$

Referring to the table given on page 379 of the March issue of MINES AND MINERALS, we find that a $1\frac{1}{2}$ -inch plough steel rope, weighing 3.65 pounds per lineal foot, has a breaking strain of 110 tons, and will therefore be suitable for this load. Correcting for the excess of weight over that of the assumed rope, we find for the maximum pull on the rope

$$T = (32,000 + 3.65 \times 1,500) \left(.5 + \frac{.866}{40} \right) = 19,548.8 \text{ lb.,}$$

say 19,550 lb. Hence, using this rope, we have for a factor of safety $\frac{110 \times 2,000}{19,550 \times 2} = 5.62$, which is ample.

[There is some difference between the weights and breaking strains of 7-wire haulage ropes (see Table, page 522, MINES AND MINERALS, June, 1900) and those of 19-wire hoisting ropes (Table, page 379, MINES AND MINERALS, March, 1900). The former should have been referred to in place of the latter, but the difference is small.]

Load Upon Engine.—Using the same notation as before and letting

W_1 = weight of descending empty trip (pounds),

L = load upon the engine, or difference between the ascending and descending pulls (pounds),

we have,

$$L = (W - W_1 + wl) \sin a + (W + W_1 + wl) \frac{\cos a}{40}.$$

Substituting the given values, we have

$$L = (32,000 - 12,000 \times 3.65 \times 1,500) \left(.5 + \frac{(32,000 + 12,000 + 3.65 \times 1,500) .866}{40} \right) = 13,808.6 \text{ lb.}$$

Size of Engine Required.—The horsepower of each cylinder will be

$$\text{H. P.} = \frac{13,808.6 \times 750 \div 33,000}{33.8} = 314 \text{ effective horsepower.}$$

With an engine efficiency of 60 per cent., the total horsepower required will be $314 \div .60 = 523.3$, say, 523 horsepower.

Assuming a second-motion duplex engine, running at 240 strokes per minute, and the ratio of the stroke to the diameter of the cylinder, $\frac{1}{4}$,

$$d = \sqrt[3]{\frac{u}{.7854 \times p \times r \times n}}$$

where d = diameter of cylinder (inches),

u = work per minute (inch-pounds),

r = ratio of stroke to diameter of cylinder,

p = mean effective cylinder pressure (pounds per square inch), and

n = number of strokes per minute.

Substituting the given values, we have,

$$d = \sqrt[3]{\frac{523 \times 33,000 \times 12}{.7854 \times 80 \times \frac{1}{4} \times 240}} = 21.76, \text{ say, } 22 \text{ inches,}$$

and the length of stroke = $21.76 \times \frac{1}{4} = 5.44$ inches.

Making the diameter of the drum 80 times that of the rope,

we have for the diameter of the drum $1\frac{1}{2} \times 80 = 120$ inches = 10 feet.

Let r_1 = the ratio of the diameter of the gear wheel to the diameter of the pinion,

v = the speed of winding (feet per minute),

D = the diameter of the drum (inches), and

n = the number of strokes per minute.

Then we have,

$$r_1 = \frac{\pi D n}{2 \times 12 \times v}$$

Substituting the given values, we have

$$r_1 = \frac{3.1416 \times 120 \times 240}{2 \times 12 \times 750} = 5, \text{ nearly.}$$

Therefore, the gearing should be in the ratio of 5 to 1.

EVAN C. DAVIES, Duryea, Penna.

Second Prize.—J. EDWARD MILLS, Belle Vernon, Penna.

QUES. 601.—*Second-Motion Engines*.—What advantages are to be gained in the use of second-motion engines? Describe the general conditions under which they should be employed in hoisting and haulage.

Ans.—The advantages of second-motion engines are: (1) Slow starting and landing speeds. (2) Speed of winding more easily controlled by the engineer. (3) Smaller size engine required for the same load. (4) High piston speed with economy in use of steam.

In general we would use this kind of engine for short and moderate length hauls, hauls somewhat longer, but with difficult landings, and in places where boiler pressure was rather low.

First Prize.—CHAS. E. BOWRON, Birmingham, Ala.

QUES. 602.—*Percentage of Gas in a Ventilating Current*.—The ventilating current in a certain district of a mine is charged with gas to the amount of 3 per cent., as shown by the Shaw gas-testing machine. The ventilating pressure in this mine gives a water gauge of 2½ inches. A fall upon the main intake has so reduced the volume of the air current that the water gauge reads only 1 inch. Determine the percentage of gas in this current.

[Many have failed in their replies to this question, which is in no sense a catch question, but one requiring a little thought. In an analysis of this question, which should always be made first, it would be well to ask the following:

1. Where is the quantity q measured?
2. Does this contain gas?
3. Where is the gas test taken?
4. What volume of gas relative to the circulation (q) does 3 per cent. represent? Is the gas 3 per cent. of q ?—EDITOR.]

QUES. 603.—*Ventilation of Dip and Rise Workings*.—An inclined seam is worked both to the rise and dip from the bottom of the shaft. The inclination of the seam is 35°. The length of the main incline to the rise is 400 yards, while the dip has a length of 300 yards. The average temperature of the intake airway to the rise is 45° and to the dip 50°; while the temperatures of the return currents, after traversing the gangways of the rise and dip workings are 60° F. and 70° F., respectively. The ventilation in this mine is produced by a fan which is circulating a current of 80,000 cubic feet per minute; 50,000 cubic feet going to the rise workings and 30,000 to the dip workings. The water gauge at the foot of the shaft is 1.5 inches. Owing to an accident the speed of the fan has been reduced and the water gauge has fallen to .5 inch. Determine the quantity of air that will be in circulation under these conditions in both the rise and dip workings.

[No correct answers to this question have been received.—EDITOR.]

CATALOGUES RECEIVED.

In writing for catalogues, please mention *Mines and Minerals*.

C. W. HUNT Co., West New Brighton, Staten Island, N. Y. Pamphlet No. 008. 15 pages.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa. Circular No. 1028, "Rotary Converters."

J. GEO. LEYNER, 729 17th St., Denver, Colo. "The New Leyner Rock Drill." 26 pages. Handsomely illustrated.

DEAN BROS., Steam Pump Works, Indianapolis, Ind. "Catalogue No. 40, containing lists of parts of pumps, directions for operating pumps, and tables of information. 56 pages.

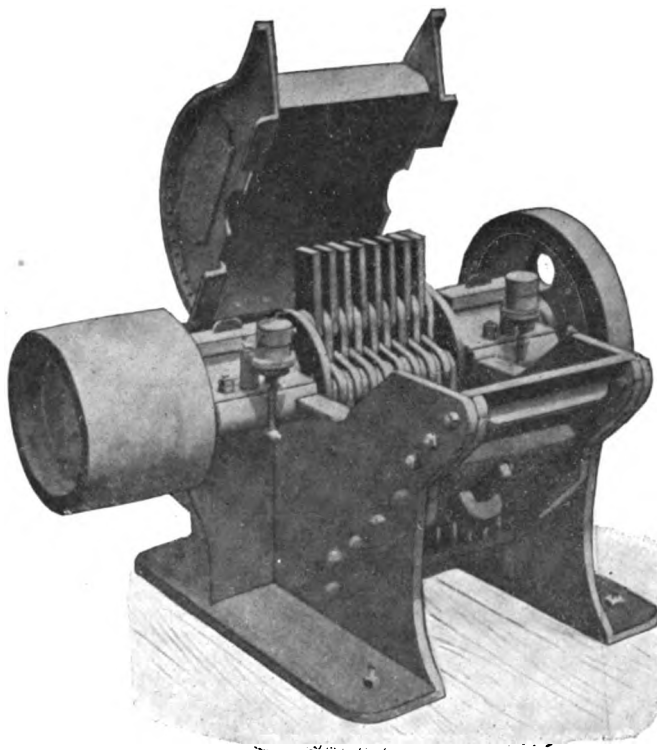
RANSOME & SMITH Co., 17 Ninth St., N. Y. "Ransome's Patent Concrete Mixers." 20 pages, showing a number of different views of these mixers and also containing many testimonials from firms using them.

GENERAL ELECTRIC Co., Schenectady, N. Y. "Lighting Arresters," 29 pages; Price List, No. 7527, "Parts of Brush

Arc Generators"; No. 7528, "Parts of Carbon Feed Arc Lamps for 110 Volt Direct Current Circuits"; Bulletins No. 4220, "Automatic Circuit Breakers, Form CD for 125 and 250 Volt Direct Current Circuits"; No. 4221, "the GE-54 Railway Motor"; No. 4228, "Continuous Current Railway Switchboards"; No. 4227, "The CE Motor"; Flyer No. 2056, "Combined Switch and Magnetic Cut-Out for Car Lighting."

The Williams Pulverizer.

The accompanying cut shows a sectional view of the Williams patent pulverizer and crusher made by the Williams' Patent Crusher & Pulverizer, Co., 2701-2707 North Broadway, St. Louis, Mo. This crusher although comparatively new has been quite widely adopted and the reports of the work being done by it are very favorable. The cut here shows the mechanism of a No. 3 crusher designed to take run of mine coal and reduce it to any size down to coarse meal. The crusher works on the hinged hammer principle, the hammers being pieces of steel 4" in width and 1" in thickness, weighing about 16 lb. each and swung upon steel bolts 1½ inches in diameter. The center shaft 4" in diameter is mounted on self-oiling dust proof journal boxes and upon the



WILLIAMS HAMMER PULVERIZER.

shaft are disc plates made of cast steel 1" thick which carry the hammers. The shaft revolves at 800 to 1,500 revolutions per minute, the coal being struck by the point of the hammer only and each hammer striking not more than ¼ inch surface of the coal at one time. At a speed of 100 revolutions per minute 52,000 blows per minute are struck, thus insuring very rapid breaking and pulverizing. To regulate the size of the crushed material the machines can be easily adjusted.

The peculiarities of these machines are that they reduce and break by a combination of abrasion and percussion. Owing to the hinged character of the hammers the accidental introduction of a horseshoe or a railroad spike in a hopper does not injure the crusher. The hammers are easily replaceable by any blacksmith and the cage bars are also equally easy of renewal. The hopper also has a removable breaker plate which can be reversed or renewed when worn out. The crushers thoroughly crush and mix the coal and reduce it to a uniform fineness. The percussive blow thoroughly loosens the tissues and fiber of the coal so that when placed in the coke ovens it cinders together and the heat penetrates uniformly all particles of coal, producing hard fine coke uniform in structure.

About 400 of these pulverizers are at present in use in the United States and Great Britain and the reports of their working are very satisfactory indeed. Complete details and particulars can be secured from the Williams Co.

MINING WRINKLES.

For original contributions upon mining or metallurgical topics descriptive of new and handy devices and appliances we will pay at the rate of five dollars (\$5) per column, payment to be in technical or scientific books to be chosen by the contributor.

Water Car.

By Daniel Weston, Black Diamond, King County, Washington.

No doubt many of the readers of MINES AND MINERALS have had trouble with water cars when the water has risen above the guide rails, or some other appliance used for keeping the car from floating when it strikes the water.

I experienced this trouble myself some years ago. To overcome this difficulty I conceived the idea of attaching a piece of sheet iron to front of car. The sheet to be the same width as car, and length from three to four feet according to pitch of slope. The sheet does not require to be as long on, say 45° pitch as it would on 35° for the sheet would be more submerged on the former than latter pitch and the water would exert more pressure on same. The sheet can be bolted to bottom of car with stays running from front of sheet to top of car. This idea has been put into effect and is still used here and it has given entire satisfaction. The plate can be put on so that it can be taken off when there is no use for it.

A New Device for Reheating Compressed Air for Use in Pumps.

Too much attention has been given of late to the economical production of compressed air to the detriment of the economical use of compressed air in motors. As applied at present to the ordinary direct-acting steam pump there is utilized only a fraction of its intrinsic energy, and many are the complaints directed against the economy of compressed air, on account of the very small returns which are made by these pumping devices.

Of course the readiness with which an ordinary direct-acting steam pump can be set up in a mine, and air turned into it, is the great reason for the numbers which are in use today. In other words, the problem is one of utility rather than economy. An ordinary direct-acting pump does not use air expansively, therefore but little can be expected from it, about 20 per cent. of the useful effort of the air being all that is converted into water pumped.

In many places pumps of this character cause considerable annoyance from freezing, and for this reason compound direct-acting pumps cannot be used with cold air. One can readily see that if the temperature of the exhaust of an ordinary direct-acting steam pump is from 20 to 30 degrees below zero, which frequently causes stoppage from freezing, that to exhaust this low temperature of air in a compound cylinder and further reduce its temperature to perhaps 100 would be an impossibility, because it could not work longer than the time which it took to reduce the temperature of its cylinder to the freezing point.

A compound direct-acting pump, which is heated sufficiently to prevent its freezing, will pump twice as much water for the same amount of air as a single-acting pump. If a single-acting pump will not freeze in working under ordinary conditions, introducing the air into the cylinder, we will say at 60 degrees temperature, the compound pump will not freeze if the air entering the compound cylinder be brought up to this same temperature.

If the ventilation in a mine is such that a reheater can be established underground, of course there is no difficulty whatever in running compound pumps, and very economically at that. There are some mines that do not object to carrying a steam pipe into the lower levels for the purpose of furnishing heat for the low pressure cylinder, but such opportunities are infrequent, inasmuch as the temperature of the mine is raised to an undesirable point, and in carrying steam a long distance it becomes an expensive operation.

A problem which occurred to the writer was to attempt to run plain compound pumps without any extraneous source of heat by utilizing simply the heat stored in the water being pumped at ordinary temperatures. The result was an installation of a Worthington pump having a capacity of 200 gallons per minute at a lift of 600 feet in the Gwin mine, Calaveras County, California.

The manner in which the installation was made was as follows: A 300-horsepower Wainwright copper corrugated heater was placed in the suction pipe of the pump, the water being pumped passing through the corrugated copper tubes at a temperature of from 60 to 70 degrees. The air after being exhausted from the high-pressure cylinder at a pressure of about 35 pounds, passes into the shell of this reheater and around the outside of the copper tubes. The extremely low temperature of the exhaust from the high-pressure cylinder is thus neutralized

by coming in contact with the water in the copper tubes, while the temperature of the air is raised to practically that of the water. It then passes to the compound cylinder, does its work and is exhausted without freezing.

Before installing this compound pump on the 600-foot level of this mine a Worthington sinking pump had been used to pump out the water. The compressor furnishing the air to this pump made 55 revolutions to actuate it and to supply power for a hoist and to overcome pipe leakage, the latter two items taking about 20 revolutions of the compressor, leaving 35 to be used for the pump. When the compound pump was put in place the revolutions of the compressor dropped down to 35, which showed a gain of 50 per cent. in favor of the compound proposition with its reheating.

The work being done at this mine was to pump out an old shaft 1,500 feet deep, which had remained idle for about twenty-five years. The water was therefore foul and inky in color and full of decomposed slates. This frequently coated the inside of the copper tubes and materially lessened their conductivity for the heat contained in the water, the result was that the pump froze up. After cleaning the tubes, however, the pump operated as freely as before, showing conclusively the advantage of the system.

A still further gain would have been accomplished had the pumps been specially constructed for this character of work and the high- and low-pressure cylinders been water-jacketed, permitting either the suction or the discharge water passing around the jackets and thus keeping them at an even temperature.

This apparatus can be installed in the discharge pipe or in the tank adjacent to the pump where the water accumulates in the mine and can overflow it freely. Moreover, this is the proper manner of applying heat to air used in a compound pump. Many pumps have the air heated before it goes into the initial cylinder, which is economical as far as the initial cylinder is concerned, but by actual observations the writer has found that the clearances between the high- and low-pressure cylinder are such that the exhaust from the high-pressure cylinder loses a considerable portion of its pressure before the stroke commences, and the drop in pressure causes such a drop in temperature of the air entrained between the two cylinders that the virtue of the reheating affects but slightly the compound cylinder where it is most needed. To be really an economical proposition the air should not only be heated before it goes into the high-pressure cylinder, but in the receiver between the two cylinders and also in jackets around the two cylinders. There is no doubt that by doing this reheating properly in compound pumps where steam or highly reheated air is used, that the efficiency of this pump can still further be raised 25 per cent.

If compressed air engineers desire to hold their own against the installments of electrical pumps they must employ more economical processes for pumping water, and pump builders can assist materially in constructing pumps properly for such work, and the above device will be found extremely economical and useful where heat cannot be safely introduced underground. —E. A. Rix, in *Compressed Air* for July.

Tungsten.

A paper on this rare metal was read before a meeting of the Mining Society, of Nova Scotia by Mr. A. C. Ross. He said it was usually found associated with tin, and in an ore known as wolfram or wolframite. The metal is especially valuable as an alloy for steel, on account of its hardening, toughening and self-tempering qualities. It only requires 9 per cent. of tungsten to be alloyed with steel to give a self-tempered tool steel of great durability. "Mushet" steel, manufactured at Sheffield, contains this percentage, and sells for seven times as much as the highest priced ordinary tool steel. Tungsten steel has great magnetic properties, some specimens showing as high a remanent magnetic moment as 62 units, as against 37 units for "diamond steel," 5 units for "Martin steel," and only 3 for "Bessemer steel." The production of the metal today in the world does not exceed 1,000 tons. The demand greatly exceeds the supply even with the existing high prices. Ore has been discovered during the past year in Nova Scotia, but to what extent is as yet unascertained, which analyzes as follows:

Tungsten trioxide	66.32
Silica	6.25
Manganese	12.02
Iron	.12

In the case of the real wolfram the percentage of iron is much higher, and this tungsten must rather be called a hibrenite, which is supposed to be rarer than wolfram. It is a difficult metal to mine, occurring in bunches in the vein, which itself twists about in an extraordinary manner. Besides the present discovery, deposits are worked in Germany, Bohemia and Texas, while it has recently been found in Nevada. It also occurs in the Cornish tin mines.

LAKE SUPERIOR COPPER MINES.

Why the Copper Output Does Not Respond as Readily as the Iron to an Increase or Decrease in Price.

Written for MINES AND MINERALS, by H. J. Stevens.

The difference between the iron and copper mining industries is a radical one, much as the two lines of mining resemble each other at first sight. The iron trade has been aptly called the barometer of American business interests, and like the real barometer with its column of mercury, the fluctuations are numerous, and at times sudden and severe. The average iron mine can be reopened on short notice after long idleness, but the reopening of a copper mine is a matter of years. The iron miner must adjust his efforts to the requirements of the market for the near future, while the producer of copper is necessarily working with a view to the general average of conditions for a decade to come, being unable to adjust his efforts as a whole to the minor fluctuations of the copper market. The big mines can, of course, adjust production to immediate demand to some extent, but the fluctuations in output of even the largest mines are comparatively slight. The stimulus of very high prices enjoyed by the Lake Superior copper mines for the past two years has resulted in increasing the annual production of the red metal less than 10 per cent. per annum. John Stanton, of New York, the veteran authority on the American copper trade, estimates the increase of product of copper for the entire United States at no more than 10 per cent. for the year 1900, the increase for the first half of the year being but 9 per cent. This increase is barely sufficient to provide for actual requirements, and the increased production of foreign lands is scarcely as great as the average in this country.

Despite the many flourishes of trumpets and the tens of thousands of dollars expended in the columns of the press, advertising the numerous Calumet & Hecla in embryo, which were to make their shareholders wealthy on small investments, the production of all the new mines, together with the increased output of all the old mines, did not exceed 10 per cent. last year, will not exceed the same amount this year, and probably will show no greater gain in 1901. The immediate future of the copper market seems assured. With a strong and steady demand for all the copper that can be mined, the price of the metal, high though it may be, is supported by the logic of demand and supply. What may be the future of the copper market in five or ten years is a matter of conjecture. The high price is stimulating production, and while, from the peculiar conditions surrounding copper mining, it is impossible to open new mines rapidly, the nature of the business is such that a strong stimulus once applied is more lasting in its effects than in industries where supply can more readily respond to demand. There are many good copper mines being opened throughout the Union, and many more new mines in other countries.

In a few years the effect of renewed effort in copper mining over the entire globe must be plainly felt in largely increased production. This much is certain, and what the effect of doubled production will be within six or seven years must depend almost wholly upon the progress of electrical development. Should the utilization of electricity proceed at its present rapid rate of increase both in America and abroad, the world's supply of copper in 1907, which will probably be nearly double the production of 1900, will no more than meet requirements. Should, however, there be a marked falling off in electrical construction, either in the United States or Europe, or in both, there will be hard times in store for many of the mines, and 8-cent copper is probable for a time. The best mines of Michigan, Montana, and Arizona are making copper at 6 to 9 cents per pound, and the cost of production can be materially cut if the necessity arrives. The mines are now earning larger profits than ever before in their history, and are paying the highest scale of wages, while expenditure is not being stinted in any direction. This policy of lavish expenditure in prosperous times is censured by many short-sighted and greedy shareholders, who grumble because all of the vast profits are not paid out in dividends as rapidly as earned, but the well managed mines are putting themselves in splendid position for withstanding the slings and arrows of outrageous fortune when a time of trouble comes. Enormous surplus funds are being accumulated, new mills are being constructed and filled with the best and costliest machinery, new docks are being dredged, wharves and warehouses built upon their banks, railroads are being constructed, shafts enlarged, mammoth hoisting plants and air compressors installed, houses erected for employes, and money is flowing like water into scores of channels. Perhaps some of this cash is wasted, but the greater part is being wisely expended, where it will remain in safety and return good interest. All these expenditures mean greater efficiency in mining and milling—a large scale of operations, greater

production per man, smaller losses in the tailings, with mining, transportation, and milling charges reduced to the minimum. When the time comes, as come it must, sooner or later, when the metal again sells at 9 cents or lower, the good mines now spending money so freely will be in a position to rest on their arms and earn excellent profits at almost any selling price for copper. The expensive construction work now under way can be reduced to a minimum and, in many cases, done away with entirely. A cent or two, or even three, can be cut from the cost of making copper, without seriously reducing wages. In addition to the saving thus made possible, the cash surplus funds will act as a balance wheel and will enable regular payment of dividends regardless of sudden fluctuations in the metal market.

The theory and practice of mining are nowhere in a more advanced state than in the Lake Superior copper district. Nowhere upon the globe are the mines so deep or so well equipped with machinery of the largest size, though the Transvaal mines of South Africa are a close second in these particulars. The largest mines of the Lake copper district have taken another great step in advance, by their methods of finance, and to a large extent have eliminated the element of chance from the fiscal conduct of their properties. The copper-bearing lodes of amygdaloid and conglomerate found in this district are of altogether exceptional permanence and uniformity. Unlike the gold, silver, and copper mines of other districts, operated on fissure and contact veins, the cupriferous lodes of the Keweenaw Peninsula are apparently bottomless, though as a matter of fact the copper-bearing formation extends under the bed of Lake Superior, the reverse fold of the synclinal outcropping on Isle Royale, 40 miles to the northward of the shafts on the mainland. This eliminates very largely the element of hazard as to the continuance of the mineral reserves which are the future life of any mine, and the conservative managements of several of the best properties have pursued a fixed policy of betterments in prosperous times, and steadily increasing surplus funds, which have finally placed their shares with the best managed railroads or manufacturing concerns. Mining is usually regarded as a hazardous occupation for workmen, and an extra hazardous investment for capital, but thanks to a happy combination of practically inexhaustible ore bodies and far-sighted financing, the best of the Lake Superior copper mines have advanced into a new class of preferred investments.

OBITUARY.

JASPER R. RAND was born September 17, 1837, in Westfield, Mass., of a family dating its American ancestry from 1635, and including two colonial governors; and which was well represented in the Revolutionary War. He obtained his education in the public schools and academy of his native town and in Fairfax, Vermont. His earliest business connection was with his father, who was a manufacturer of whips when Westfield was the headquarters of that industry. In 1865 his father retired from business, and Mr. Rand and his younger brother, Mr. Addison C. Rand, succeeded him.

In 1870 he removed to New York, and was for a time associated with another brother, Mr. Albert T. Rand, president of the Lafin & Rand Powder Company. In 1872 Mr. Addison C. Rand began the manufacture of the Rand rock drills and other mining machinery, and the two brothers subsequently organized the Rand Drill Company, with Mr. A. C. Rand as president and Mr. J. R. Rand as treasurer, which arrangement continued until the death of Mr. A. C. Rand in March last, which left the chief office vacant, when Mr. J. R. Rand was elected to the position.

When the Messrs. Rand became interested in rock drills, they were in the pioneer stage, with—at most—a small and uncertain future before them, but they have come to be an essential part of every mining outfit. Rock drills were among the first American machinery products to find recognition among foreign engineers, and they are today at work in nearly every country on the globe where the mining industry has passed beyond the most primitive stage.

In 1873, Mr. Rand removed his residence to Montclair, N. J., where he has ever been prominent in local affairs. For three years he served on the Town Council; was for two years a chosen freeholder of Essex County; a charter member and first president of the Montclair Club, serving also another term; for fifteen years he was a trustee of the Congregational Church. He was one of the organizers of the Bank of Montclair, of which he was continuously the president. He was a member of the New England Society, the Hardware Club, and Engineers' Club of New York City; and for forty years a member of the Mt. Moriah Masonic Lodge of Westfield, Mass.

He was practically acquainted with every field of business life from that of traveling salesman up. He had a remarkable fund of wit and of pointed, but stinging, repartee, which made him the most delightful of companions—qualities which naturally

brought him friends without limit. These and other qualities also made him a presiding officer under whose gavel it was a delight to sit. He was interested in all public enterprises and contributed generously to their support.

Mr. Rand died Wednesday, July 18, and was buried at Westfield, Mass., July 20. He leaves a widow, a daughter, and a son, the latter now representing the Rand Drill Company in Paris.

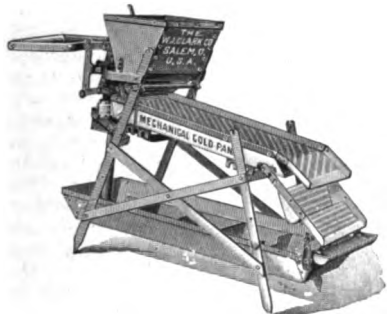
COLONEL J. D. KASE, manager of the North Carolina Steel and Iron Company, died at Greensboro, N. C., on Monday evening, July 9. Colonel Kase has been a resident of Greensboro since 1891, when he went there to assume the position of manager of the above named company. He was a native of Pennsylvania, and for many years was connected with the iron industry at Danville, in that State. He was a graduate of Washington College, Pa., and 66 years of age. Some years ago, he accompanied the late Congressman Kelly, of Pennsylvania, to Alabama, and looked into the matter of developing what was then the dormant iron industry of that State. This trip, and the subsequent work of Messrs. Kelly and Kase, was a great factor in the development of the iron industry of Alabama. Colonel Kase was a man of sterling honesty and great ability, and his death is a decided loss to his adopted State.

JOHN R. DAVIS, of Scranton, Pa., died at his home in that city Thursday, August 9, after an illness of six months' duration. Mr. Davis was 78 years of age, and had been a resident of Scranton for the past 40 years. He was born in Norristown, Pa., March 27, 1822, where he spent most of his younger days. At the age of 18 he took charge of a country school, but soon entered business in Philadelphia, and later in Pottsville, where he was clerk for a coal operator. He later had charge of the coal department of the Ashland Iron Works at Wrightsville, York County, Pa., and still later engaged in the retail coal trade in Baltimore, Md. In 1851 he took charge of the Black Diamond Colliery, Wilkes-Barre, Pa., and in 1855 came to Scranton, where he built and owned the Stafford Meadow Brook Colliery. Since that time he has been closely identified with the mining interests of the Lackawanna Valley.

FRANKLIN PLATT, the well known scholar and scientist, died recently at Cape May, where he was spending the summer. Mr. Platt was a Philadelphian by birth, and since his early boyhood has been devoted to the study of geology and kindred subjects. Early in life he served on the Geological Survey of the United States Government, and in later life has acted as geologist for many corporations and business men, his reports and books based on these resources being well known. He was at one time president of the Rochester and Pittsburgh Railroad. He was a member of numerous Philadelphia clubs, of the American Institute of Mining Engineers, the Philadelphia Geological Society, the Historical Society, and numerous other scientific bodies.

Mechanical Gold Washer.

The W. J. Clark Co., of Salem, Ohio, has placed on the market a mechanical gold washer for cleaning up battery and pan residues which have heretofore been hand panned. It is also designed for placer mining where the ground is rich and water scarce.



The washer measures, when set up ready for use, 18 inches wide, 4½ feet long, and 3½ feet high. The framework is made of ½" × 1½" wrought iron, and the pans and screens are made of No. 16 galvanized sheet steel. The hopper has a "grizzly" 10 inches wide by 17 inches long with perforations ½" × 1½". The perforations in the upper screen are ½" × ¾", and in the tail screen ¾" × 1". The hopper has an adjustable gate on the side next to the pump which discharges the material onto the screen in the rocking pan. The pump has a 4½ inch bucket, and a spout 7½ inches wide which spreads the water over the material as it is discharged from the hopper. The ends of the pump levers strike buffers on the hopper (which is on pivots) and give it a rocking motion, while the rocking pan, carried on swings, is given a back and forth movement by means of toggle links connected to the pump levers, so that the pan has double the number of motions of the pump.

In the bottom of the rocking pan is a riffle tray with 11 cast iron grooved riffles for catching the gold. Beneath the riffle tray, burlap is placed to catch fine gold. The tail screen gets motion from the rocking pan, and has a pocket to catch the nugget gold which is not retained by the riffles, and the

tail screen delivers into a mercury trough which ordinarily catches the floating gold, but when there is much fine and floating gold, amalgam plates may be readily inserted.

The bottom pan contains an inside tray with plain riffles, over which all the water flows, and the tray is removable for cleaning out. The bottom pan also has a pipe plug at the lowest end for draining all the water out when required. It takes about 12 gallons of water to fill the lower pan. The pump takes its supply from this pan, and the machine is so arranged that the water from the washing process flows into the bottom pan, and is thus used again and again continuously, requiring very little addition of water to keep the machine in operation. The capacity of the washer is said to be 200 to 300 cu. ft. of material per day when operated by two men, while one man can with it clean ten to twenty times as much as he can with a hand pan. The other advantages claimed for it are that it will catch fine gold that could not be saved by hand panning; it can be operated satisfactorily in many places where hand panning is not profitable; it can be taken apart easily and packed in the lower pan (without boxing), and measures when thus packed 15 inches high × 18 inches wide × 4 feet long—weight, 250 pounds; it can be set up readily by bolting together, suitable wrenches and a duplicate set of the parts most liable to wear, being furnished with each machine.

TRADE NOTICES.

The Campbell Coal & Coke Co., A. M. Schenck, manager, Woody, Tenn., will soon be in the market for a complete mine equipment.

The Truax Mfg. Co., of Denver, Col. reports recent orders for its regular pattern and side dump automatic ore cars, from points in Virginia and Vermont.

The Williams Patent Crusher & Pulverizer Co., 2701-2707 North Broadway, St. Louis, Mo., reports daily orders for its well known crushers, from coke makers and those wishing the coal crushed into fine slack for flushing purposes and from manufacturers of cement.

The Burt Mfg. Co., of Akron, Ohio, has made some important shipments of Cross oil filters on export orders in the past month. These orders come from Denmark, Sweden, Spain, France, England and Mexico. Notwithstanding the unsettled condition of Europe, their export business is steadily increasing.

The M. C. Bullock Mfg. Company has recently sold a diamond drill to the government of Chili, and another to the government of Nova Scotia. Within 30 days diamond drills have been sent to Spain, Japan, Turkey, Antofagasta, and various parts of the United States. The following have also been shipped, a compressor and rock drill plant to the Sea of Azof; two mine ventilators to West Virginia; hoisting plants to the Black Hills, Mesabe Range, and Illinois Coal Fields; a Willans engine to St. Petersburg, another to the Massachusetts State Farm, and an 800 I. H. P. Corlies engine is now being erected for the American Cereal Company.

The Borden & Selleck Co., 48 to 50 Lake St., Chicago, manufacturers of conveying machinery of all kinds, and general agents for the Howe scales, reports being behind on orders for scales and warehouse trucks. The company looks for continued good business through this year, except in sections where crops are poor. Among recent orders completed or under construction, taken by the company are the following for conveying machines: Soo Line, freight handling conveyors run by a Howe 30 h. p. gasoline engine for transferring freight at Gladstone, Mich.; Rutland Transit Co., new warehouse equipped with five freight carriers on incline for handling freight from dock to freight house and to boats; coal handling machinery and coal screens, including rope transmissions and gasoline engines for the following: Koenig Coal Co., Detroit, Mich.; O. S. Richardson & Co., Chicago; Uhrig Fuel Co., Milwaukee; North Ave. Fuel Co., Milwaukee; C. Reiss Coal Co., Ashland, Wis.; and H. M. Benjamin Coal Co., Milwaukee, Wis.; coal and ash handling machinery for the Evansville Cotton Mfg. Co., Evansville, Ind.

As suggestive of the fact that just as hot and fluid iron can be produced in a cupola operated by a fan blower, as is necessary even for stove foundry conditions, the following statement from James McKinney & Son, of Albany, N. Y., is of interest:—"We cannot use a dull iron, therefore the above melting, (9½ pounds of iron per pound of coal) means that the iron comes out of the cupola just as hot as would be used in the ordinary stove foundry. We can melt on an average in our cupola, 5 tons in not to exceed 1 hour. In many cases we do much better than this, depending upon how much we let the blast in. In a heat of 10 tons we can melt the iron in from 1½ to 1¾ hours."

PERU'S MINING INDUSTRIES.

Facts In Regard to the Various Ores and Minerals and the Extent to Which They Have Been Exploited.

Written for MINES AND MINERALS, by H. L. Geissel.

The exploitation of mines constitutes at present, perhaps more than ever before, a rich resource for the future of the Peruvian Republic.

Peru is, indeed, one of the countries of the world whose soil contains the greatest variety of minerals. In the north we find petroleum and the sulphur of Piura; the coal deposits of Hualgayoc, and the important beds of argentiferous lead of Ancash. In the center there are the great mining districts of Cerro de Pasco, and of the Province of Huarochiri with the famous copper mines, argentiferous lead, coal, rock salt, etc.; the phosphates of Ica and the ancient quicksilver mine of Santa Barbara. In the south, we find the borax of Arequipa, the gold-bearing veins of Huayllura, Sandia, Carabayá, and the placers of Inambari.

The total number of mines under exploitation is estimated at about 2,500 and the workmen employed at 70,000. The value of the minerals exported has increased by 56 per cent. within two years, and amounted, in 1898, to 9,481,213 soles, or, taking the silver sol at the average rate of exchange for that year, viz., 42 cents, at \$3,982,109.

The following remarks give a clearer idea of the mineral richness of Peru:

Aluminum.—Sulphates of aluminum occur in pretty large quantities in the northern provinces, but the deposits are not being worked; smaller deposits of phosphate of aluminum and copper (turquoise) have also been found in the neighborhood of Huari, in the province of Azacucho.

Antimony.—This mineral occurs in almost all forms all over Peru. The abundance is so striking that the population of the Andes Cordilleras attribute the mountain sickness, known under the name of "soroche," to the antimony evaporation. The exportation of this mineralizing substance and its combinations is at present effected via the port of Mollendo. In 1898, the exportation reached the amount of 27,186 tons, of which 23,255 tons went to the United States and the rest to Great Britain.

Silver.—Pure silver exists in small quantities; it chiefly occurs in connection with copper, lead, and other minerals. In these forms it is found in the provinces of Ancash, Junin, and Lima, where one encounters the rich mines of Huaraz, Cerro de Pasco, and Huarochiri. Contrary to all expectation, the decrease in the value of this metal and the suspension of coining silver money in Peru, have not decreased its exploitation, and its exports show rather a notable tendency of increase. Thus, in 1893, the exportation of silver was as follows:

	Kilograms.
Silver bars, etc.	89,959
Silver minerals	13,772,480
Silver and lead minerals	837,178
Silver and copper minerals	964,748
Silver lead and gold minerals	22,356
Sulphurous silver	188,135

Arsenic.—Native arsenic appears only in small quantities; in the central provinces arsenic occurs in the form of sulphur, chiefly accompanied by metallic sulphurs, such as mispickel, enargite, and some varieties of gray copper ore. It is, however, very little exploited.

Bismuth.—This metal occurs associated with iron, antimony, silver, and other ores; the most extensive combination is the chiviatite which exists in large quantities in the provinces of Cerro de Pasco and Huarochiri. In 1898, 400 kilograms of bismuth were exported through the port of Mollendo.

Borax.—for several years the attention of capitalists and financiers has been especially attracted by the bborates of soda, calcium borates, and the borax occurring in the provinces of Arequipa and Tacna.

During the last few months new deposits of borax have been discovered at Azangaro (Province of Puno), at Camana (Province of Arequipa), and at Parinacochas (Province of Azacucho), in the southern part of Peru. All the deposits occur at great distances from the coast, and the products have to be carried on mule or llama back to the railway which connects Sicuani, Puno, Arequipa, and the port of Mollendo.

The principal deposit in exploitation is that of Salinas, situated some 25 miles from Arequipa and 2,000 feet above the level of the ocean. It is the property of a German syndicate. In 1897 these deposits yielded nearly 25,000 metric tons of borax.

An English company, with a capital of \$7,000,000, "The Borax Consolidated, Limited," was recently formed at London for the purpose of engaging in the exploitation of borax deposits in Chile and Peru.

The borax is chiefly exported to Great Britain and Germany, and, to a smaller extent, to France and Belgium.

Bituminous Coal.—The different varieties of bituminous coal which occur in almost all parts of Peru, form an unappreciable reserve of richness and revenue for the future of Peru.

The absence of wagon roads and railways is today the only obstacle which has so far prevented the exploitation of mines which would be more than sufficient to feed all the markets of the western coast of America.

The two principal deposits so far known are situated in the north of Peru, in the provinces of Cajamarca and Libertad. The first one, which lies in the neighborhood of Cajamarca, embraces two coal beds extending in a length of from 20 to 25 miles; one between Hualgayoc and Chota, and the other one in the neighborhood of the Marañon River. The distance which separates these two coal beds from a navigable route is 320 miles towards the Marañon (Amazonas), and 160 miles towards the Pacific Ocean.

The second deposit is situated in the province of Libertad, 32 miles south of Huamachuco. Some of its beds, extending in a length of from 20 to 25 miles, have a depth of from 20 to 34 feet. Mining engineers say that this coal is almost absolutely pure, and compares very favorably in quality with the best Pennsylvania coal.

Important coal deposits exist also in the province of Junin (Cerro de Pasco, Yauli, Huancayo). In certain localities it is converted into coke. This coal contains a high percentage of gas which could easily be made profitable if proper steps were taken, but the gas is now entirely wasted.

Copper.—The new applications of copper in different industries, particularly in the manufacture of telegraph wires, and the increase in the price of this metal on the English and American markets have had their counterpart in Peru.

The growing demand has induced many capitalists to restart the exploitation of mines which had been entirely abandoned for a long time, and to form new companies to engage in copper mining and in the exportation of this metal on a scale hitherto unknown.

In 1898 the exports of copper from Peru amounted to 1,421,119 kilograms, made up as follows:

	Kilograms.
Great Britain	1,374,959
Chile	19,246
Germany	15,273
France	11,641

It will be seen from these figures that for the moment Great Britain is almost the absolute master of the Peruvian copper market.

There exist in Peru a considerable number of copper-bearing veins whose exploitation had to be abandoned on account of the decrease in the copper prices and the increase in the working expenses, for most of the argentiferous ores contain a certain proportion of copper. One can, however, unite the copper mines now forming the object of serious exploitation into three groups, viz.:

(a) The mines in the neighborhood of Ica, where work was abandoned in 1892, containing very varied kinds of materials. During many years they yielded ores of an average richness of 30 per cent., and could today offer a good prospect to foreign capitalists if the lack of water and fuel were not two drawbacks, which, however, could be overcome.

(b) The region of Cerro de Pasco, already famous for its silver, lead, and coal mines, possesses the richest copper deposits of the whole country. Composed of chalcosine, chalcopryite, bornanite, etc., they contain sometimes as much as 60 per cent., the average being 40 per cent. There is little doubt that these deposits will in the near future play a great role in the mining industries of Peru. These deposits have recently been closely examined by Mr. Michael Fort, Professor at the Mining School, of Lima. The conditions for the exploitation of these deposits are quite different from those existing in the Ica districts; fuel and water are abundant, and the distance (which can be covered in two days and a half on horseback) which separates Cerro de Pasco from the railway of Callao to Oroya will soon cease to be an obstacle as this railway will be extended to the great mining center.

(c) The deposits of Yauli and Morococha (13,200 feet altitude) rank second only as far as productive importance is concerned. For the same reason as those of Ica these mines were abandoned to give way to the exclusive working of silver deposits. Today, with the increasing copper prices, the exploitation has again become lucrative. The richness of poor ore is here from 10 to 15 per cent.; this ore is sold at a low price to the great establishment of Casapalca, as they cannot afford any high transportation. However, the general opinion prevails that if these ores were worked by the fusion process, on the spot, even veins containing 8 per cent. could be exploited successfully.

We may also mention in connection with these deposits those of Acari in the province of Camana. The trials made there, however, by "The Acari Copper Mining Syndicate, Limited," are said not to have given satisfactory results.

Be this as it may, a certain number of Peruvian and foreign engineers are now studying, on the spot, the copper deposits in this district.

Tin.—Many people have been investigating the tin deposits in Peru, though tin occurs only in small and unimportant deposits. In 1898 the total exports of tin did not amount to more than about 2 tons, which were shipped via the port of Mollendo. Bolivia, however, has considerable tin deposits.

Magnesium.—On the coast of Peru a number of good and marketable magnesium salts are found, amongst which the sulphate of magnesium (Epsom salt) is the best known. The deposits are, however, little worked.

Manganese occurs in many districts of Peru, but it is chiefly associated with copper, silver, lead, antimony, and iron ore. The deposits, as a rule, are not extensive, and therefore the output is very inconsiderable.

Mercury and Cinnabar.—Peru, which in former times produced large quantities of native mercury, does not export any quantities worth mentioning, though there exist considerable veins whose length is estimated at at least 200 miles.

The celebrated mines of Santa Barbara, in the neighborhood of Huancavelica, alone produced, in the period from 1571 to 1813, more than 5,000 tons, representing a value of 75,000,000 pesos gold. In spite of the land slips which have occurred since work in these mines was abandoned it is estimated that this plant could still furnish large quantities of cinnabar for many coming decades.

The mines of Chouta, situated at a height of 15,762 feet above the level of the sea, in the province of Huanuco, mines which also were abandoned many years ago, produced an average of 14 tons a year. It is, therefore, strange to see Peru importing annually considerable quantities of mercury from Great Britain when there are such large deposits in the country itself.

Nickel.—This metal occurs chiefly in the province of La Mar, in quantities sufficient to warrant a successful exploitation. Means of communication between this province and the coast must, however, be improved before these deposits can be profitably worked.

Gold.—A story of the quartz and the auriferous washings annually exploited would fill too many columns. There is really no province in Peru where there may not be found, not only traces, but mines or important washings of this precious metal. The same as for copper, the regions of old signalized as containing auriferous minerals are today the aim of capitalists. Every day new mines are claimed according to law, and several Peruvian and foreign companies have recently been formed for exploiting the auriferous quartz deposits of Carabaya and of Sandia and the washings of Inambari. It is calculated that the total production of gold, which amounted to about 1,562 pounds in 1897, reached about 2,000 pounds in 1898.

A French engineer, who, some months ago, visited the Fair of Cojata, said that the representatives of the business houses of Arequipa had not money enough to buy all the gold which was offered by the "Puchiris" (Indian Gold Hunters).

Petroleum.—This mineral oil exists in large quantities and rich deposits in the province of Piura. The opinion even prevails in Peru that this petroleum is superior to that found in the United States, that it has less odor, and that it contains relatively little paraffin. It also is said that it gives a splendid light. The production increases every year considerably. At present several hundred wells are worked, and in 1898 the total production of petroleum amounted to more than 745,000 gallons, which means an increase of 45 per cent. within one year.

Several foreign companies are engaged in the exploitation of these petroleum fields. Prominent amongst these is the Italian Piaggio Co., which is doing very well. The French South American Petroleum Co., which is also established in the above-mentioned province, has not had such good results as the Italian company.

Asphaltum and Bitumen are also found in the provinces of Peru, and small quantities are exported to the neighboring republics.

Phosphates.—These salts, which are now so largely used for agricultural purposes, have been the object of the closest study of the Peruvian Government for the last two years, and it is said that considerable deposits occur in the neighborhood of Ica, and especially in the Pampas of Ocuja, though they have not been worked to any extent so far.

Lead.—This mineral is chiefly associated with silver and antimony, and is, perhaps, the most abundant of all the minerals which are found in Peru. In 1898 over 8 tons of lead were exported to Ecuador, and a quantity of about 837 tons of argentiferous lead was exported to the markets of Europe and the United States.

Salt.—The exploitation of the salt mines and salines is since three years controlled by the government. The revenue amounts to about 1,000,000 pesos. Rock salt mines occur in the provinces

of the north and south, and also in the central provinces. The "Cerro de la Sal," in the province of Junin, has for a long time been exploited by savage tribes who live still in that district. The annual production is estimated from 30,000,000 to 40,000,000 pounds. The greater part of this is consumed in the country, and only small quantities have so far been sent to the Argentine Republic and to Colombia. The latter republic, in 1898, received about 120 tons.

Sulphur.—Sulphur deposits are found in the neighborhood of all the volcanoes, and also in many other districts, especially in the neighborhood of Tumbes, in the province of Piura. The principal veins occur in the neighborhood of Sechura, in the same province. They embrace a large number of veins whose thickness varies from 1 to 20 feet. They contain from 52 to 70 per cent. of sulphur. The district, however, where these veins are situated, is an absolute desert.

In order to enable the exploitation of these sulphur beds it would be necessary to construct at least a narrow-gauge railway line about 25 miles in length to the port of Salinas.

Before concluding our remarks on the mineral industries of Peru we have still to mention marble and mineral waters.

Marble of a very good quality occurs in many districts, and during the last two years it has been worked on a larger scale than ever before.

Mineral-water springs occur especially in the south of Peru, where the greatest number of volcanoes are situated. The mineral waters of Yura are principally appreciated by foreigners, who use them as table waters. The exportation of these waters to the neighboring countries of Peru has also been started. Last year a new company was formed to exploit more commercially these water deposits. In the Province of Ica one encounters also marvelous springs of sulphuric waters, and quite a number of bathing places have been established there of late.

The Lapidary Industry of Birkenfeld.

The cutting and polishing of precious and half-precious stones forms the chief industry of the little principality of Birkenfeld, up among the hills of the Nahe River, and gives employment to over 5,000 persons.

Although an improved factory system is gradually superseding the laborious methods of former times, there are nevertheless plenty of the old polishing and cutting works, which bear evidence to the lives sacrificed to this industry.

In the early days of the trade, agate quarries existed in the near-by hills, and this half-precious stone was cut and polished by a very laborious method, which is still practiced, although the agate quarries have long been exhausted and the raw material—as well as amethyst, jasper, opal, topaz, etc.—has been imported (since about 1834), chiefly from Brazil, whence it is shipped to this out-of-the-way place to be cut, shaped, and polished for the jewelry trade.

The usual method employed in cutting and polishing these stones is the following: In a rude hut by a stream, which furnishes the power, four large grindstones about 4 feet in diameter are so fixed that their axes are only about 1 foot above the floor, into which a slit is cut, so that part of the grindstone is below its level. This lower portion passes through the water, thus keeping the stones constantly wet.

The operator has a bench or block of wood about 18 inches high, hollowed out to receive his chest and body. On this bench he lies at full length, and with his fingers holds the small piece of opal, amethyst, or other stone which is to be cut, against the grindstone, slightly above the level of the floor. In this position the men lie from morning to night, day after day. Consumption usually carries them off at an early age, but other men are found to follow this vocation, as the earnings are comparatively high. The operator usually owns his grindstone, or at least half of one. This represents an investment of about \$500, and a skillful lapidary can earn from \$15 to \$25 per week. He does not usually cut and polish stones on his own account, but generally contracts with manufacturing jewelers, who furnish him the stones in the rough, to cut and polish at a certain price per gram. As the stones, even in the rough, represent quite an outlay of money, the honesty of the workman must be greatly relied upon, for nobody can say in advance how many grams of finished stones a certain piece of opal, amethyst, or the like may yield.

Besides these half-precious stones, precious stones such as diamonds, etc., are also cut and polished there; but this is an entirely different branch of the industry and is chiefly carried on in factories with modern machinery. Another branch of the industry in these parts is the cutting of cameos.

Pearls are also polished, drilled, and cut and shipped in large quantities to all countries, including the United States, invoices covering single shipments of the value of \$60,000 having been certified to at the consulate at Mainz.—U. S. Consular Reports.

RIB DRAWING WITH MACHINES.

A Proposed New Method of Mining Coal by the Use of Longwall Undercutting Machines for Taking Out the Rib.

By W. S. Gresley, Mining Engineer, Erie, Pa.

By this method, the ribs, as planned and formed in the mine, will take the shape of blocks or pillars, becoming ribs in fact only as they are reduced in size by a special method of working. Using the old word rib, however, what follows will probably be better understood and appreciated by the mine official and the practical coal miner than the term pillar, which, in room-and-pillar systems usually refers to the chain or entry pillars and to stumps.

The new plan is to apply more particularly to seams of coal that contain considerable refuse, the Pittsburgh "thin vein" for example, and those with good roofs, and it aims at abolishing pick work as far as possible, namely, to undermine or cut the ribs with machines from one end to the other. To accomplish this, the breast type of machine is not to be used, neither is the puncher, or pick type contemplated unless experience, test, or circumstances shall demand the one or the other, but it is the longwall type that, if I mistake not, is going to do it.

Let the entries, rooms, and the narrow work be cut with the machines now in vogue; and, having formed or blocked out the ribs separating the rooms, take slice after slice (skip after skip) off them, using a longwall machine for the purpose in the manner suggested below. Now, by the plan in question, the ribs are to comprise the largest proportion of the coal to be worked, so that instead of having the rooms wider than the ribs the latter will be the wider: perhaps the ribs will be two-thirds (66 per cent.) of the whole. With this object in view, and since the longwall machine under favorable conditions cuts very much more coal than the breast or puncher type, the anticipated result, if secured, should be a decided gain to the coal operator.

The operation or problem then, as I have thought it out, would be about as follows:

First.—Drive the productive or butt entries as wide as practicable, and say three of them in parallel (making a 3-entry system of it) to the limiting line of the section or district to be worked by the new method. Gob the slate and refuse if possible, piling some up where least likely to hinder the future or the second stage of the machine work, and try to avoid turning any rooms until the entries are up their distance.

Second.—Turn rooms their full width (why have any necks?) off the flanking entries (see *x* and *z* Fig. 1), beginning along the

line or boundary, and on both sides if the coal is flat, but on the rise side only if there is too much dip. These rooms, numbered 1, 2, 3, 4, 5, 6, etc., on the plan, must be worked on sights and kept straight and of uniform width; also the slate and refuse is to be placed on the side shown; the position of the track being nearer to one rib than the other (see thick dotted lines in rooms numbered 5 and 6).

Third.—Cut over between the heads of the rooms, casting the rubbish against the boundary, not against the ribs. The ribs, say *A* to *F*, will then be ready to start upon.

Fourth.—To take out the ribs. This work is intended to be done all in one direction, namely, retreating or outwards, i. e., the ribs on the right hand of the entries are to be worked off on the right hand of each room, those on the left hand (on entry *x*) to come out towards the left hand; and in this way to leave all

gob, falls, and caves behind as the rib drawing proceeds. This method then provides for taking out the ribs on the butt of the coal, or end on, where the seam is pronouncedly cleated, faced, or jointed. The rib-cutting machines are to travel along the sides of the ribs, cutting while traveling, from one end to the other. The cuts or runs referred to are indicated by parallel dotted lines upon the ribs marked *A*, *B*, *C*, *D*, etc., and the successive slices or skips of coal to be undercut and removed one after another are marked respectively 1, 2, 3, 4, 5, 6, etc., upon those ribs. The number of slices to come off each rib, of course, will depend upon the width of the ribs, the width of the cuts, and the width of the remains of the rib that may be found to be unworkable. Whether the machine cut be made going up the room or coming out thereof, is immaterial, the object is to get the full length of the rib undercut so that when the sprags, or other

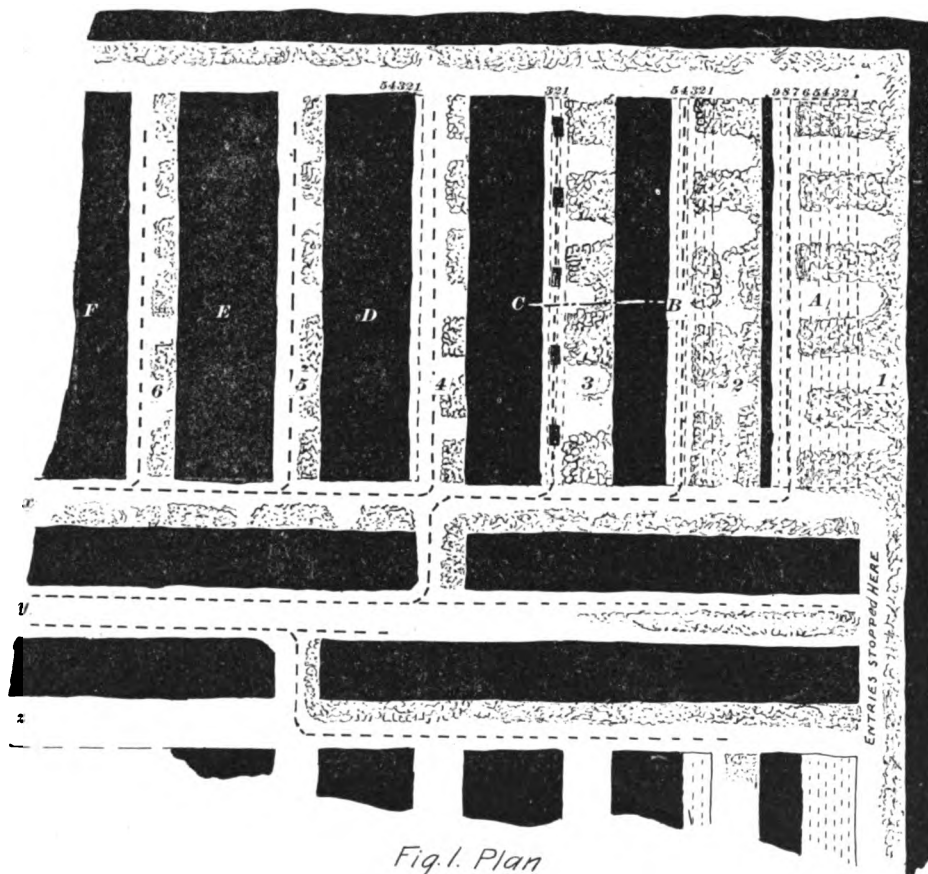


Fig. 1. Plan



Section on Line C B.

FIG. 2.

timber supports to the face are knocked out, the coal is free to fall, or to be taken down; and then broken up, cleaned, and loaded out. As each successive skip or slice of coal is cut and removed from a rib, the track is moved over a few feet nearer the working face and the posting brought up as closely as possible to the cars standing upon the track. In room number 5 five cars are shown distributed along the face of the rib ready to be loaded with coal coming off slice number 3 of rib *C*. As to the method or system to be practiced in the rib drawing, the first rib, marked *A*, should, I think, be pretty well reduced before the second one, rib *B*, is commenced, and the third rib *C* should not be started until, say *A* is about finished and *B* well under way; but actual practice will be our best teacher. Anyway, the quicker these ribs are worked out the better will the result be. And of course the ribs on both entries should be drawn simultaneously and come out evenly: likewise the entry pillars, bringing up the rear. Perhaps the longwall cutters may

be used to advantage on these pillars by slicing them up longitudinally—on the face.

Fifth.—In this way then each rib will get narrower and therefore weaker as each skip is taken off it. The last few skips will be the critical ones—the real test of this method, especially so when several adjacent ribs in each range are coming out together, and when the first weight or the fall over the gob has been felt. And this point brings us to the question, namely, How do I propose to hold up the roof over the working faces in the ribs, or, in other words, how are the rooms to be kept open and safe to work in until the ribs are out or as much of them as possible, pulled? My answer is this: I do not claim to be able to take out all of the rib coal; in my opinion from 3 feet to 5 feet in width and the length of the rib will have to be left, partly for the reason that the last strip or shell of a rib will become too much weighted or crushed to work, and partly to serve as a protection to the next rib or room in advance of it. The idea that I have in mind in this connection is to make this last thin wall or shell of rib coal next to the gob of the adjoining room serve as a temporary support to the roof while the places are being worked, but as soon as finished, abandoned; it will have served its purpose and collapse, thus letting the top, the cover, settle down upon the worked-out area. The last few feet of rib we have just been speaking about is shown in Fig. 1, rib marked A, between slice or skip numbered 9 and the gob in room number 2. Of course in some cases wider strips of the ribs may be required to be left; in others, little or none need be lost. But in addition to this narrow shell next to the gob of the room ahead of it, my idea includes, if indeed it does not demand, caring for the slate and refuse taken down or made in the working places. This refuse and slate then, is to be systematically piled up from floor to roof in such manner as will best carry or support the same and steady the top during the removal of the ribs. To this end then, the slate and dirt produced in driving rooms—heading-out the ribs as we may fairly regard it—is to be dealt with so as to give as much lateral support to the ribs as possible, as well as help the posts hold up the roof. Perhaps the greatest use to which the refuse could be put will be secured if the stuff is built up as solid as possible into pillars or isolated blocks, which, as the rib drawing proceeds, shall be extended or take the form of wide walls somewhat in shape as sketched in plan (Fig. 1), room 1 and rib A; but to make these heaps of refuse of any real use they must be well built and built right up to the roof. The more thorough and systematic this pack building is done, the less coal will be wasted in rib pulling and the greater should be the saving in timber. Of course, the amount of coal it will be impossible to save in the drawing of ribs will depend to some extent on the depth of the mine, the strength of the seam, and other factors.

Doing the undercutting, with machines, it will be very important to keep the weight off the ribs, for the last few cuts in them especially, and much skill and judgment will be needed in regulating and superintending this work and that pertaining to the use and distribution of the debris, and more particularly the timbering and timber drawing of the places.

Referring again to the matter of reducing the ribs to their narrowest dimensions; in other words, of minimizing loss of coal, an inspection of the rooms and ribs marked, respectively, 1 and 2 and A and B on Fig. 1, will show that the narrower the rib becomes, the greater grows the area of support derived from the piled-up refuse, to say nothing about the posts, which, for the sake of clearness, have been left out of the figure. Particular attention is directed to this point in the system, for the reason that although the area of solid coal remaining is small it probably possesses great resistance to crushing or squeeze since it is well supported in front by large and heavy and solid piles of slate, etc., while back of it stand say two rows of posts, and these posts again are backed up by stout piles of slate. With all this precaution, it seems to me that the loss of coal in ribs would be quite light, and the chances of losing valuable material in them, very small.

Sixth.—What the width of the blocks of coal separating the rooms—the ribs—ought to be, is a matter more for trial and experiment than to be discussed here. The wider the better, I would suppose, provided the loss of coal can be kept within reasonable limits and the working places maintained. The best length also is a matter not to be overlooked.

Seventh.—If the method here outlined were given a fair test and resulted favorably, it is easy to see that a very economical system of car distribution and gathering might be arranged. The empties could go up and be left in one room or rib and the mule and driver pass on and down the next place, taking the loads out onto the entry. Many more men could be put to work in a very much smaller area of working places than is at present possible, thus concentrating the work and mining the coal much faster. A considerable saving in posts might result, and there would be fewer workings and less entry, etc. to maintain.

Eighth.—Of course nothing short of an actual test of this plan can decide as to its merits or demerits and determine its relative economy with present practice. The idea was explained to two very practical men, and both were so desirous of giving it a trial that the writer persuaded the operator to order the longwall machine for the rib work, but before the work could be started the mine changed hands, and, although the machine was built, the matter has probably been dropped.

As to the records of longwall mining machines, it may be remarked here that there are three or four kinds or types on the market, and that each has made a good showing and done good work under varying and favorable conditions in Illinois, Iowa, Missouri, Indian Territory, and elsewhere. To get best results from them, the ends of the ribs or pillars should be left free or clear of refuse; straight faces to cut; and faces as long as possible; with every facility for transportation from one rib to another in order to minimize loss of time.

Ninth.—Dimensions have purposely been omitted from the plan, Fig. 1, because if anybody wants to try the method he should lay out the work to suit the circumstances and conditions of his seam and his mine. The plan is one offering many points for profitable study and discussion. I offer it, not as a cut-and-dried method or all theory, but as an idea—a new one, I believe, worth something more than a passing notice, to be read and then shelved. It seems to me, that in this age of coal cutting by machinery, and so long as our existing room-and-pillar method in machine mines holds sway, the loss of merchantable coal in ribs and pillars will not be materially reduced until the latter can be pulled with machines as cheaply as, or cheaper than, room coal is produced.

The writer has seen a great deal of longwall work, both by the advancing and the retreating plans. The method of drawing the ribs herein sketched, comes under the latter plan. He has also watched longwall undercutting by machines, and after 10 years' experience in the charge of room-and-pillar mines, he may, perhaps, be considered to know what he is talking about in this connection. The pages of this journal are doubtless open to receive and print comments and criticisms of practical men having something to say or writing for further details.

[The pages of MINES AND MINERALS are always open for the presentation of new ideas like those contained in Mr. Grealey's article, and for discussions and criticisms of the same.—EDITOR.]

P. & B. Products.

The Frank S. De Ronde Co., 52 and 54 John St., New York, is the sole distributing agent for all the products manufactured by the Standard Paint Co., of New York City, for many years makers of the well known P. & B. products. This agency covers all the



eastern part of Pennsylvania, etc., a full stock of these products is carried at the Philadelphia warehouse, from where prompt shipments can be made. More than 14 years of practical use have demonstrated the fact that the P. & B. paint is an excellent preparation for use in and about mines. Being free from tar and oil the makers claim that it will not evaporate, chip and peel off like the ordinary asphalt and oil preparations. It possesses extreme elastic properties, is very penetrating and being unaffected by the action of acids and alkalies, gases, fumes, and especially mine water, is particularly well adapted for coating all kinds of iron work about mines, such as pipes, pumps, screens, etc. The Frank S. De Ronde Co. is willing to send samples of this paint free of charge to any mine owners who may be interested. The Ruberoid Roofing made by the same company will certainly interest all connected with mines. The enormous strides made in the sale of this material in the past eight years is almost beyond belief. It is now in general use the world over by thousands of the largest consumers and manufacturers. Enormous quantities are consumed by such well known concerns as the Repauno Chemical Co., Wilmington, Del., New York and Pennsylvania Co., Lock Haven, Pa., as well as many of the large coal mines throughout Pennsylvania, and almost every railroad in the country. Ruberoid is not a paper roof, having as a base the best of wool and hair felt, thoroughly impregnated with the water and acid proof composition. It will not run at any heat and is guaranteed in every particular. The makers would be pleased to send samples and the names of dozens of well known users to all those who may be interested. Correspondence is invited by the makers of these well-known products, and mine superintendents needing paint or roofing will undoubtedly find it to their advantage to correspond with the Frank S. De Ronde Co. The trademark illustrated herewith is a striking one, and it will be found on all goods sent out from these factories.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *APPEARS* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 608 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Example of the Granitic Series in the Field.

Let us take as an example what we may see of granitic rocks in almost any cañon in the Front Range of the Rockies. At the entrance of the cañon we find the sedimentary rocks of the Paleozoic series of quartzites or limestones uptilted and resting upon the eroded edges of the granite; tilted usually in a contrary direction to that of the sedimentaries, so the latter rest unconformably on the former. It is very clear that here we have the old original granite island that was upraised, folded, crumpled, tilted, and eroded by ancient seas which laid down their sediments upon the battered, broken, wave-worn bases of the granite cliffs, as seas are doing nowadays against the bases of granite cliffs in our sandy bays.

The uptilted character of the stratified sedimentaries shows that after they were laid down along the shores and cliffs of the granite islands, of course horizontally, the granite island and nucleus must have taken a second rise of several thousand feet, at a later period, and carried up along its flanks and tilted sometimes to verticality the beds reposing at its base from Cambro-Silurian to Upper Cretaceous. Now all such mountain movements involve great crumpling and folding of the granite mass. First it was crumpled and folded up to rise above the ancient sea as island forms, and then the already crumpled, fissured, folded mass was again crumpled, fissured, and folded to assume mountain forms.

Granites often break up along the joint planes, giving a cliff a masonry-like appearance, as shown in Fig. 1.

Is it any wonder then that when we enter the cañon and pass into the bowels of the mountain and study the great ribs of which it is built, that we find the whole granitic series a mass of intricate crumples, foldings, fissurings, fractures, and cross-fractures,

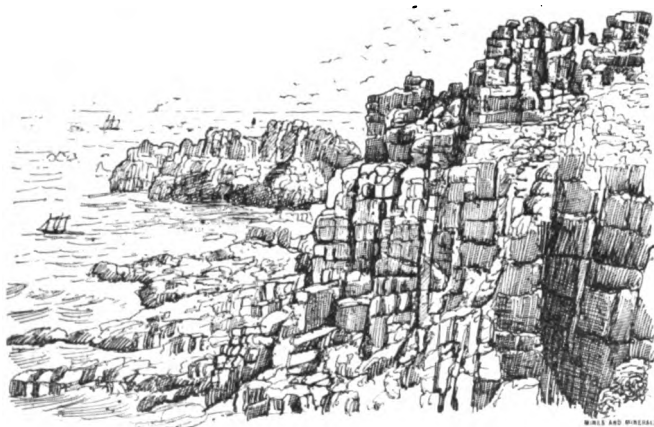


FIG. 1. GRANITE CLIFFS.

mingled with all sorts of evidence of aqueo-igneous heat and fusion, developed perhaps in part by these movements, and see on all sides of us great dike-like veins of feldspar and quartz, the matter of the rocks that has boiled over, from great veins 100 feet wide, traversing the cañon walls like broad ribbons, or in dike-like walls, down to tiny little veinlets, whose intricate puckerings we can span between finger and thumb. A moment's glance convinces us that whatever was the remote origin of the granitic series, it has evidently been once in a semiplastic condition and under inconceivable pressure, for in the first place, no rocks in a

rigid condition could be thus puckered up and folded like pieces of cloth without a multiplicity of fractures taking place both great and small; and secondly, no such folding and puckering could have been produced without the agency of inconceivable pressure, more or less laterally applied, producing the great arches forming the mountain ranges, as well as the tiny puckerings forming the detail of the rocks.

In many of our cañons, the class of granitic rocks we meet with on the flanks of the mountains and for a long way up the cañon are liable to be laminated and contorted schists and bedded gneisses. We rarely meet solid amorphous granite till we have

penetrated into the core of the range. The schists are conspicuous by their laminated structures, by their being composed principally of mica, or hornblende, and except when formed of white mica, or muscovite, by their dark color. They are generally contorted and puckered up into intricate folds, the form of which is often delineated by veinlets of pink feldspar and quartz following the course of the folds and giving the rock a beautiful marbled and banded appearance. Sometimes we find narrow lenses of quartz and feldspar following in a chain-like belt alternately opening and closing, showing that one contorted wall of schist was forced up past the other, bringing convexities opposite convexities, and concavities opposite concavities, as exemplified by tearing a sheet of paper in half and then placing the two pieces together again, only moving one half of the sheet up or down a little.

These irregular pockets and pinches are miniature forms of what we often find in ore deposits and due to the same movement. From these little segregative-interstitial veinings, pockets, and blotches in the schists, we may presently come upon much larger vein or dike-like masses, composed of very coarse feldspar and quartz, with usually but little mica, traversing the rocks. In many cases we find no absolute dividing line between these pegmatitic veins and adjacent rock, no "walls," so to speak; the quartz and feldspar seem to be closely welded to, and part of, the surrounding gray country rock (see Fig. 1) as when we cut a finger and the wound grows sore from bad blood and fills with matter, and finally leaves a white line where the old wound used to be. You could not pick out that white matter from your finger and leave the walls of flesh clear on either side. No more could you pick out the white feldspar and quartz that have healed these weak places and wounds in the rocks and leave the walls clean on either side. It seems just as in your finger, that a wound, or weak place was formed, and as blood and matter pour in from the flesh to fill that wound, so the material of the country rock composed of quartz and feldspar came in, or was segregated in, to heal the wound or weak place formed by movement in the plastic mass, and there finding greater room and expanse, crystallized out in a more coarse and sparry form than the adjacent country rock.

These might perhaps be given the name of so-called "segregative veins," the material being derived, collected, and gathered out from the material of adjacent wall rock. They are really coarse, sparry, granite veins in granitic rock. Again we find other bodies that seem to have filled a well defined, and perhaps open, fissure, the line of demarcation being very distinct between wall and vein, and even sometimes with crevices between vein matter and wall.

This would look to us like a fissure filled by material rising from below rather than filled from matter from the immediately adjacent wall. Be it however as it may, it is nothing but a vein of sparry granite in granite. These latter are most of our ore-producing veins of the granitic regions, such as those of Clear Creek, Gilpin, and Boulder counties.

From the laminated schists we pass to an intermediate series of banded and sometimes contorted gneisses, too solid massive to be called laminated schists, yet showing a banded and sometimes contorted arrangement of the layers of mica and feldspar, not unlike the schists containing also more quartz and feldspar.

From these again we pass to the heavy bedded granite gneisses, a piece of which, in a hand specimen, we would call granite but which in the field shows a distinct heavy bedded structure, different from the definition of true granites, which are generally supposed to be massive, like lump sugar, and to be more or less structureless.

Algonkian Gneisses and Schists.—In South Boulder Cañon, and in several localities in Colorado, we find on the flanks of the true Archaean series of granite rocks what appears to be a later series

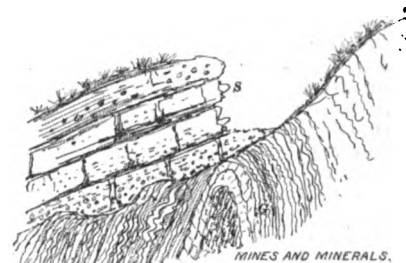


FIG. 2. BEDDED GNEISSES AND SCHISTS.

called the Algonkian. It consists of bedded gneisses, quartzites, and white mica schists. The bedded gneisses are full of white blotches, flattened and elliptical, which seem to be the metamorphosed relics of the ancient water-worn quartz pebbles, of which the original rock was formed before it was metamorphosed into a gneissic crystalline condition (Fig. 2).

As regards the schist we appear to observe that by compression and greater metamorphic action, the loose leaves of schist are bound up into the volumes we are apt to call gneiss. Blotches of iron occur in these sericite schists which, with greater metamorphic heat develop into garnets forming a garnetiferous gneiss, and gneiss by greater aqueo-igneous heat and metamorphic action may pass into true amorphous granite.

Granite as a Mining Rock.—As a series for containing veins carrying precious ores, as well as baser ones, the granitic series is notorious. Most of the fissure veins carrying gold and silver are in this class of rocks. Lead, copper, zinc, and iron also occur abundantly. Granite has been thought by some to be the parent rock of gold, the original matrix whence the gold came. Gold is not only found in place in veins in granite, but, at times, diffused through the rock itself.

A striking example of this is in the coarse, red feldspathic granite forming the wall rock of the noted Independence mine at Cripple Creek, Col. By ascending hot mineralizing and acid waters the granite has been robbed of some of its decomposable elements; the dark micas or hornblendes have been oxidized out and replaced by gold-bearing tellurides. This granite has sometimes been so much disintegrated of its oxidizable constituents that it almost falls to pieces in a mass of quartz sand. The decomposed granite is shipped wholesale as ore from a zone of many feet in width.

Besides occurring in so-called quartz or rather pegmatite veins in granite, gold is doubtless more or less distributed through the great masses of granite; and the rivers, the world over, that show "colors" in their sands have largely derived these, more from the general breaking up and disintegration of mountains of granite than from gold-bearing veins in the granite. In the veins the gold may be concentrated, whilst it may be minutely diffused through the mass of the rock.

ECONOMY IN MANUFACTURE

Of Mining Machinery—Its Importance to Purchasers—The Elements of Costs and How They are Determined.

By Charles H. Fitch.*

The elements of cost in mining machinery are complex, and as sundry of them are commonly estimated as proportional to others, any change in the latter is multiplied in the aggregate like an extension of lazy tongs.

The basal elements are weight and value of materials (to which a small percentage of cost is added for warehousing), and time and rate of labor. These are obtained for every considerable portion of every job, by the use of cards sent out to the shops from the office, and returned with the required data. These cards are a great convenience. A pack of them girt by a rubber band is the shop record of basal elements of cost on a given job.

In the factory office, clerks transcribe the card values of labor and materials upon broad cost sheets with tabular rulings. To these sheets pinned together as folios the selling correspondent resorts in fixing the figure which he asks the mining man to pay for the machinery.

These figures, however, necessarily include other costs and expenses of a general character not belonging to any particular job. Such expenses are called burdens, and are taken off from time to time to establish the ratios which they bear to the aggregate of assignable costs.

The foundry, smithy, machine shop, etc., each has its separate burden. Above these is the burden of office expense, management, advertising, selling, shipping, and reasonable profits of business, if any. These constitute additions to the price, none of which the customer ought to escape.

In manufacture, as in mining, labor is the most important basal element, but its cost does not form so large a part of the value of product in manufacture as in mining.

In the foundry, costs of materials, supplies, and other expenses, usually exceed cost of labor, and this fact makes the foundry a specially promising mine for economy of administration. Small details of buying and use assume handsome aggregates in the course of a year, and should enable a painstaking economist, with proper recognition and authority, to earn a good salary in many of our large general foundries, and at the same time provide a good extra profit for his employers, that is, if their competitors

do not get equally clever and devoted men, economize in their foundries, and then cut prices to correspond in the selling.

The mining product is staple and its price is fixed by market conditions, but the machine factory product has an elastic value, and is multiform in specification. The mine manager has a consistent and one-sided problem—to reduce cost of production, and so leave a larger margin of profit. The works manager has a double problem, to be economical in production and also liberal to his own interest in selling. His profit is not a natural find. It is grudged him on both sides, by the workman with whom he economizes, and by the customer who would like to economize with him, and is able to do so when competition eliminates the capital value of his betterments, and tends to leave him with no rewards but those due to a higher form of skilled labor.

Not a few highly-organized shops making engines, machine tools, and other fine machinery are poor dividend payers. Especially do those shops fail to pay dividends in which the stock-holding interests are partly alienated. If two party interests become alienated the majority in control does not relish paying tribute on a large block of minority stock, but would prefer to divert the dividends to betterments and large salaries to preferred persons in executive places. With such persons dominating the office end of a works, liberality rather than economy is the rule of service. Privilege and favor leak down, sinecures are allowed and become patterns to subordinates. The enthusiasm for economy is impaired by practices distinctly opposed to it, and held in higher favor. It is seen that there is not one rule for all, and the effort for economy becomes more perfunctory than strenuous in those of whom it is expected.

The manufacturer locates himself in a nest of accumulating expenses which build about and hinder his growth. If he expands to employ a city he is taxed on city values, and must pay unearned increments out of earnings. He has not the bulwark and advantage of the mine operator in possessing a bank of found value to draw upon. To share this advantage the factory must enter into partnership with the mine, and in such a union it is the mine which will have the capitalistic and potential preponderance. Although one man or company may control both, it is the mine which will in effect employ the factory, and pay dividends. This will happen when factory processes are completely economized, and there is no liberal margin left in the business.

Systematic economy is not easy to realize. In the large manufacturing shop, building to contract, character of work is varied and changing. With continual change of conditions there is difficulty in making comparative checks upon efficiency. On the other side the selling is influenced by favor and personal prejudice, by wide variations in specifications, and in claims of merit, specious or real, and by premiums on time delivery due to the improvidence of users of mining machinery. Among these vicissitudes system and economy are evasive, and are not easily corralled.

Despite its difficulties of attainment the manufacturer pursues, and is obliged to pursue, systematic economy, and making virtue of necessity proclaims the customer to be a sharer in his saving. But if, as would appear, the competitive chasing of such economy tends to thin his profits to the breaking point, it is a pursuit akin to the "Hunting of the Snark," in which Lewis Carroll satirizes all forms of futile and impracticable propaganda. One of the hunters of this mysterious creature is described as finding it, and simultaneously disappears, whereat the poet observes:

"But beware if the Snark be a Booby, for then
You will swiftly and silently vanish away,
And never be heard from again."

With this peril in view, if the contagion of *economy* is to infect our profits we do not care to pursue it with inconsiderate zeal.

But the mining man is expected to have no such scruples in behalf of the manufacturer. Let him look to his own economic interests, now much neglected. His societies can exist to no better purpose than to specify that which is finest for his purposes, avoiding improvidence, the heresy of cheapness which is not economical, and ancient and freakish features of machinery which are not to the best purpose.

If the first cost of what is best is now formidable it is largely due to the improvidence of the mining man. Let him essay the task of specifying the best, and making his specifications standard. Then the manufacturing effort now spent in catering to meaningless and uneconomical variations will be confined to more uniform lines. Manufacturers can and will then produce the best at much less cost than now for two reasons:

1. There will be removed an element of uncertainty in the selling, which now greatly increases prices.

2. The problem of shop work will be presented in its most advantageous economic form, namely: The repeated production of one kind of work to which a man can give his undisturbed attention until it is unerringly accomplished in the best way.

* Read before the Lake Superior Mining Institute, February, 1900.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Many of the questions given by the several State Boards of Examiners suggest principles which can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question, which should be as brief and concise as possible. It is the purpose of MINES AND MINERALS, to discuss in this department of "Examination Questions" the principles of practical mining upon which these questions are based, feeling sure that such articles will be appreciated by and be a help to all who are preparing themselves for mine examinations.

Mine Inspectors' Oral Examination, Held at Des Moines, Iowa, March 7, 1900.

QUES. 1.—If appointed State Mine Inspector, how would you proceed to make your first examination of a mine?

ANS.—I would proceed to the mine, make myself acquainted with the mine officials, and after a brief inspection of the mine maps in the office, I would proceed at once to examine minutely and in detail the equipment at the surface. I would begin at the engine room, examine the engine, take notice of its style and manner of working, and particularly of the brake controlling the motion of the drum. I would converse briefly with the engineer in charge, and would then proceed to examine the boilers and fittings. I would next proceed to the shaft and examine carefully the hoisting ropes, cages, wings, safety catches, gates, and other appliances. Before going into the mine, I would examine carefully the ventilating apparatus, if this were at the surface, making note in my memorandum book of the speed of the fan, its size, and whether the same was an exhaust or a blow-down fan. I would desire the engineer to lower me slowly into the shaft, giving me an opportunity to examine the shaft lining as I descended; I would observe carefully the working of the cage in the shaft, the signals given at the upper and lower landings, as well as the signals given in response by the engineer. I would examine carefully the bottom of the shaft, its timbering, the arrangement of tracks, and the manner of handling the cars. I would notice if there was provided a proper manway around the shaft, and would next proceed to the intake airway or the foot of the downcast shaft. Having carefully observed here if the speed of the fan, as ascertained by counting its pulsations, was the same as it was when I was at the surface, I would select a suitable place in the airway, not far from the foot of the downcast, and having measured the size of the airway at this point, I would as carefully as possible obtain an average reading of the anemometer at that point of the airway; and would make a memorandum of the same in a book carried for the purpose, being careful to note also the correct date of my visit. I would then proceed inbye upon the intake airway, observing the character of the stoppings, timbering, and the general condition of the air course. I would examine also every door, overcast, or brattice upon my way, as I followed the air on its course through the mine. I would, from time to time, measure the air at different points in the airway, and ascertain if the full amount of air was passing. This would show whether the doors, stoppings, bridges, etc. were air-tight, or if the air was leaking at any point. I would measure the quantity of air going in each split at the mouth of the split. I would measure the air also at the inside breakthrough of each split, and would see that these breakthroughs were all of a proper size, and were free from any incumbrances such as tool boxes, powder kegs, etc. I would go to the face of the rooms and examine carefully the condition of the working face; the amount of timber and caps on hand in the several rooms and working places. I would talk with the men, giving them a fair opportunity for making any suggestions whereby, in their opinion, the general conduct of the mine might be improved. I would further examine all airways and haulage roads with respect to their size, timbering, drainage, and general arrangements. Returning to the bottom of the shaft, I would examine carefully the pumps, and inform myself particularly in regard to the efficiency of the drainage system of the entire mine.

QUES. 2.—Explain how the condition of the weather and direction of the wind may affect the production of gases in coal mines?

ANS.—Whatever conditions operate at the surface to alter the ventilating pressure in the airways of a mine, affect at once the amount of gas issuing from the old or abandoned workings. A fall of barometric pressure is felt very soon in the mine workings, and the gases contained in the old rooms and abandoned places of the mine expand in proportion to this fall of pressure, and flow out upon the airways, where they mingle with the air current of the mine. A strong surface wind may also produce a fall of ventilating pressure, if it acts directly to oppose the current dis-

charging from the upcast of the mine. In gaseous mines, there is always an increase in the gas issuing from the coal or from feeders in the mine, whenever there is a fall of barometric pressure. It has generally been observed that the fall of barometric pressure precedes the effect in the mine, by from two to three hours, and thus gives a sufficient warning to provide against the increase of gas which is sure to follow.

QUES. 3.—What precautions should be taken in entering an abandoned mine?

ANS.—The precautions necessary to be taken in entering an abandoned mine relate particularly to the condition of the mine with respect to gases. In Iowa, this danger relates particularly to the presence of blackdamp or carbonic-acid gas (CO_2), or whitedamp, carbonic-oxide gas (CO), since there is very little, if any, marsh gas in the coal seams of this State. The danger is greater when there has been very little circulation in the old workings, and especially if there is a tendency to gob fires, since in such a case there would be a large amount of whitedamp given off. The presence of whitedamp is not as readily detected, when entering an abandoned working place, since the lamps continue to burn brightly in this gas. The effect of the gas is deadly, as it poisons the system, producing unconsciousness and death in a comparatively short time.

QUES. 4.—What is meant in the science of mine ventilation by the term "equivalent orifice"?

ANS.—In mine ventilation, the resistance offered by the mine to the passage of a ventilating current is often compared to the resistance offered to the flow of any fluid through an orifice in a thin plate. In each case, the velocity of the flow is proportional to the square root of the pressure or head which actuates the flow. The expression for the velocity of any fluid under a certain head

(h) is given by the equation $v = \sqrt{2gh}$, or since $v = \frac{Q}{a}$, we have

$Q = a \times \sqrt{2gh}$; and introducing the coefficient for the *vena contracta* in the flow through an orifice in a thin plate, we have, finally, $Q = .615 a \sqrt{2gh}$. In this equation, h is the head in feet actuating the flow. This can be reduced to inches (i) of water gauge, thus, $h = \frac{1,000}{1.2 \times 12} \times i$. Substituting this in the above

equation, and solving with respect to a , we have $a = \frac{.00038 \times Q}{\sqrt{i}}$.

This last equation gives the value of what is termed the "equivalent orifice" of a mine. It is the ratio between the quantity of air in circulation, and the square root of the water gauge producing the circulation. It is, in fact, the size of orifice in an imaginary thin plate which will pass this quantity of air under this pressure.

QUES. 5.—What are the uses of the following instruments in connection with coal mines: Anemometer, thermometer, barometer, and water gauge?

ANS.—The anemometer is used to determine the velocity of an air current. This instrument is shown in Fig. 1, and consists of a small vane having its blades inclined to the plane of revolution. The inclination of the blades is such that one revolution of the vane corresponds to a movement of the air of 1 foot, so that when the vane makes 60 revolutions in 1 minute the air is traveling at a velocity of 60 feet per minute. The revolutions of the vane are communicated to a recording dial upon the face of the instrument, by means of a series of gears. There is at the top of the instrument a small catch by which the hands of the dial are thrown out of or into gear, thus enabling the instrument to record the movement of air for an exact period of time, as noted by the watch.

The thermometer used in mining is the ordinary house thermometer. It is employed to ascertain the temperature of the air current, since any change in the temperature of a current will affect at once the volume or quantity of air in circulation. For this reason it is always important to note the temperature in connection with anemometer readings in careful investigations.

The barometer used in mining is usually the mercurial barometer. This is stationed upon the surface near the mouth of the mine. The aneroid barometer is sometimes employed when readings are to be taken in the mine. The barometer is used to indicate the atmospheric pressure. This is important in mining practice, since any change in atmospheric pressure affects the volume of the gases in the abandoned workings of the mine.

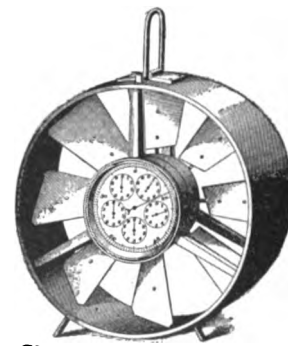


FIG. 1.

A fall of barometer or a decrease of atmospheric pressure, results shortly in the expansion of the gases in the abandoned workings, and causes them to flow out upon the airways and mingle with the air current. This will often produce dangerous conditions. On this account the barometer is carefully watched at large mines, especially where dangerous gases are being given off in the workings.

The water gauge and its use have been fully described in answer to Ques. 30, page 273, MINES AND MINERALS, January, 1900.

Ques. 6.—What are the different noxious gases found in the coal mines of Iowa? Give as fully as possible what is known of the properties, dangerous character, and method of detecting each of them.

Ans.—The gases occurring in the mines of Iowa are as follows: Carbonic-acid gas (CO_2), blackdamp; carbonic-oxide gas (CO), whitedamp; there is no marsh gas in the coal seams of this State. The properties, character, and methods of detecting these gases are fully described in answer to Ques. 3, page 85, MINES AND MINERALS, September, 1899.

Ques. 7.—How would you determine whether a cage and its attachments are safe, as operated in a mine?

Ans.—I would examine carefully the construction of the cage in regard to its workmanship and material. To determine any points of weakness, either in the cage itself or the rope or chains by which it was supported, I would subject it to a test by means of a heavily loaded car or other weights much in excess of what it would ordinarily be required to carry. I would also direct the engineer to start this load suddenly from the bottom, if I had any doubts as to the security of the holdings. In regard to the safety catches, I would have the rope so arranged that the cage could be cut loose, at some point in the shaft, when carrying a loaded car to satisfy myself of the working condition of the catches and their ability to prevent the cage from falling to the bottom of the shaft. I would also examine the guides from the top to the bottom of the shaft to see that they were secure and strong.

Ques. 8.—Describe in detail how you would test the scales at a mine, to determine their accuracy.

Ans.—I would first carefully balance the scale beam when the platform of the scales was empty. I would then place standard weights of 50 and 100 pounds upon the scale platform, testing the weight of each by the scale beam. I would then remove these weights and run an empty railroad car upon the scale platform, and, having balanced the weight of the car, I would again test the scales by the addition of the 50- and 100-pound standard weights. I would do the same again, using a loaded railroad car. In all of these tests I would require that the scale beam should break easily and correctly. These tests should be made at a time when there is no wind pressure operating upon the scale platform; since this may readily produce a difference of from 50 to 100 pounds.

Ques. 9.—In mining coal by the pillar-and-room method, what should be the rule for determining the size of pillars and relative size of rooms?

Ans.—The general conditions determining the size of room pillars are: (1) Depth of seam or thickness of cover, which determines the roof pressure. (2) Strength of roof and character of bottom; a hard roof or soft bottom requiring thicker pillars, while with a soft roof or hard bottom the pillars may be of less width. (3) The character of the coal, a soft frail coal requiring thicker pillars; while with a hard coal the width may be decreased. (4) The thickness of the seam increases the size or width of pillar. (5) The inclination of the seam also affects, to a greater or less extent, the thickness of the pillar, steep seams requiring thicker pillars than are necessary in seams of less inclination.

The size of openings, or width of rooms or chambers, depends largely upon the same conditions. (1) Thickness of cover or depth of seam, which determines the roof pressure, affects directly the width of the opening. The latter decreases as the depth increases. (2) A weak roof or soft floor, or frail coal each decreases the width of the opening, while a strong roof and floor, or hard coal may permit of wider openings.

No rule, other than a general rule, can be given for determining the relative width of pillar or size of opening. This must be determined alone by experience, in any given district.

Ques. 10.—If in extending the workings of a mine where the airways are kept of uniform size and condition, the water gauge shows an increased pressure, what, in your opinion, is its cause?

Ans.—It would be natural to expect an increase of pressure due to the increased length of airway, or an increase of rubbing surface. Also, in the extension of the mine workings, there would probably be more air required, and this would also call for an increase of pressure, unless the air current was split into two or more separate currents.

Ques. 11.—In case of an explosion in a mine, whereby, the

furnace, doors, and air stoppings were destroyed, what method would you adopt to restore circulation to admit of a prompt rescue within?

Ans.—The descent into the mine must be made by means of the downcast shaft. The doors, air stoppings, and other means of ventilation being destroyed, the shaft will be filled with the afterdamp of the explosion. This may be partially removed by means of water poured down the shaft. The work of restoring the brattices, stoppings, doors, etc. must be commenced at the bottom of the shaft. No advance can be made ahead of the air current. An attempt should be made to restore communication between the upcast and downcast shafts at once. What air current can be obtained should be carried forward by temporary brattices constructed of brattice cloth or boards nailed to rows of posts. As quickly as communication is established between the upcast and downcast shaft, the air current can be strengthened by hanging a fire basket in the upcast. The whole of this current should be directed forward along the main entry where exploration is already being made.

Ques. 12.—If the ventilation of a mine be insufficient where the power is fully utilized, what could you do to increase the amount of air in circulation?

Ans.—If the power is fully utilized in the present ventilation of the mine, the only means by which the quantity of air in circulation can be increased, without additional power, is to clear up the airways, enlarge the breakthroughs, and straighten the air courses as much as possible, thereby reducing the length the air must travel. All old curtains and brattices that are not required should be taken down, and the air be made to travel in as direct a course as possible. If this does not produce the desired result, recourse must be had to splitting the air; that is to say, causing it to travel in two separate currents, which has the same effect as increasing the area of the airway. The volume of air passing will be directly proportional to the number of splits made, provided these are of the same length and the power remains constant. The pressure will be reduced in the same ratio as the quantity is increased under these conditions.

Ques. 13.—How would you proceed to reduce the number of doors in a mine, and still maintain a good circulation of the air? What advantages would be gained by so doing?

Ans.—The number of doors required in the ventilation of a mine, is reduced by building overcasts at the points where there were formerly doors, and ventilating each pair of entries by a separate split of air, as shown in Fig. 2. The fresh air current, or the return air, will pass over these overcasts, or bridges, according as the haulage is accomplished upon the return air, or upon the intake air course. The advantages gained by reducing the number of doors required in the mine, is the reduction of expense for trappers necessary to attend the doors upon the haulways. Where trappers are not employed to open and shut the doors, there is a loss of time to the drivers on this account, and a consequent reduction of output or increase of expense per ton of output.

Ques. 14.—Describe the proper method of constructing doors and splitting air currents in a mine. How can the currents be regulated so as to furnish the proportion of air needed in different workings?

Ans.—The proper method of constructing a mine door of use for the purpose of deflecting an air current has been fully described in reply to Ques. 29, page 272, MINES AND MINERALS, January, 1900. The air current of a mine is split into two or more currents; whenever there are provided two or more separate ways by which the air can travel through the mine to reach the upcast. The air will divide itself between these several routes, or passages, according to the resistance of each. It will usually be necessary to construct an air bridge over the haulway either for the return or the intake current of that split, or of the main current. The construction of these bridges is fully described in answer to Ques. 29 referred to above.

The proportionate division of an air current, or any division other than the natural division is accomplished by means of regulators. The regulators in use are of two forms, known as the "box regulator" and the "regulator door." The former is shown in Fig. 3, and consists of a door or brattice built usually in the return airway, because this position will generally interfere less with the mine haulage. This form of regulator is provided with

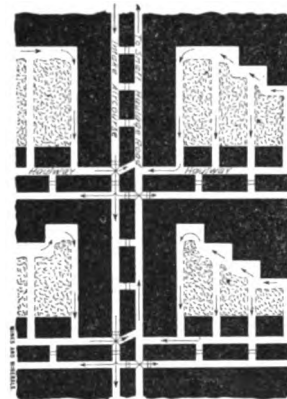


FIG. 2.

a movable slide or shutter by which the opening may be increased or diminished at will, thus regulating the supply of air in the split which it controls. The other form of regulator shown in

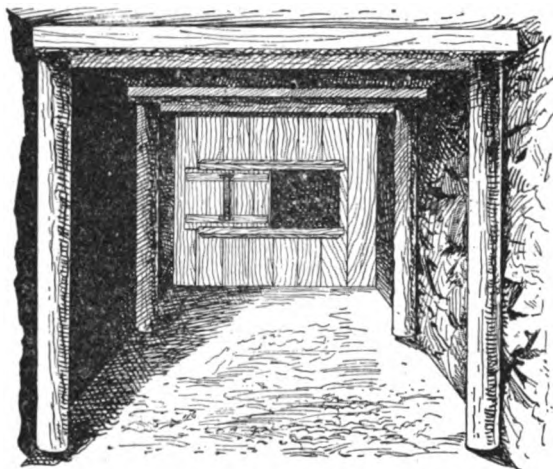


FIG. 3.

Fig. 4, consists of a door *ab* at the mouth of two splits, so arranged that its cutting edge *a* is presented to the intake current. This door is provided with a set-lock, so that its position may be fixed to divide the air current into any desired proportions, between the two airways. This latter form of regulator consumes less

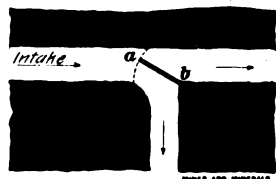


FIG. 4.

power than the former, since it does not increase the resistance of the split, as is the case when a regulator is placed at the return end of the split. In the use of the box regulator, the pressure of each split in which a regulator is placed is increased by the regulator till it equals the *natural pressure* in the free or open split; the pressure in all the splits then being equal. In the use of the regulator

door, the pressure for each split is simply the *natural pressure* of the split, and there is consequently much saving of power in the use of the latter form of regulator.

Ques. 15.—In a mine where the main air course and return are each of the same length, the roof has fallen badly in the former, while the air is foul in all the entries and working places, yet the fan is run to its full capacity. Name three ways by which the amount of air can be increased in such a mine without enlarging the fan.

Ans.—(1) The quantity of air in circulation may be increased by clearing up the falls upon the main air course, as explained in answer to Ques. 12 above. (2) The quantity of air in circulation may be increased by increasing the *speed* of the fan, but this will necessitate a large increase of power. (3) If this is a shallow mine, it may be cheaper to sink an air shaft at the head of the entries and cause the air to travel in two separate splits from the downcast to the upcast shaft. (4) It may be possible to build a furnace at the foot of the upcast shaft.

Removing a Body of Gas From Mine Workings.

The removal of a body of gas from a chamber or other working place where it has collected is often a difficult task, requiring close care and attention upon the part of the fire boss. The first duty of that official, before taking any steps toward the removal of a considerable body of gas, is to notify all the men working upon the return current who will be affected thereby. Where the accumulation of gas is large the men should be absolutely withdrawn from all working places inbye from where the gas is located, and the fire boss should assure himself that his orders in this respect have been fully carried out, both for the safety of the men in question as well as that of all those employed in the pit. The body of gas may move very quickly, and flow out upon the airway in large volume, rendering the air current highly explosive. On the other hand, the movement of the gas may be extremely sluggish, and despite every effort made to dislodge it, little progress may be made toward its removal. The fire boss cannot foresee these possibilities, however, with certainty, and his plain duty is always not only to notify the men affected, but to see that they are absolutely withdrawn.

Having increased the circulation in the affected district, as much as possible, the fire boss, with a few helpers, starts by

erecting a temporary brattice just beyond the mouth of the first room wherein such a body of gas has accumulated (see *a*, Fig. 1). This is done providing the crosscuts are open to permit the circulation to pass along the working face, from room to room, without returning to the airway. The effect of the brattice or curtain thus erected in the airway is to raise the ventilating pressure in the rooms. If these rooms are driven to the pitch, and the gas, as we have assumed, consists of a firedamp mixture, its tendency will be to rise to the face of the pitch and there remain. It will often require a considerable ventilating pressure to overcome this tendency of the gas to rise to the face in steep pitches. We have known of cases where a large body of gas, accumulated under similar conditions to these, refused, during a long period, to move at all; every effort made to start the circulation in these rooms proving unavailing. In one particular instance, as a last resort, but one thing remained to be done, and that was to start at the return end, where the current should discharge from the rooms, and erect a short brattice leading up into the chambers, as shown at *b*, Fig. 1. It will at once appear that it would not be possible to extend such a brattice far into the chamber, since the air would here be heavily charged with gas, causing the lamps to flame constantly, requiring the most careful watching, and rendering the work hazardous. The men, in this instance, were compelled to advance, set a post, nail the brattice cloth to it and retreat quickly, always keeping, however, upon the fresh-air side of the brattice. By degrees the brattice was carried up from the airway toward the face of the room, the air current traveling up one side of the brattice and returning upon the other side. In this manner, the gas was removed slowly but surely from the chambers, but the work required a most diligent watch being kept upon the lamps, and great caution being used, especially when nearing the head of the chamber. From time to time, the men went back upon the airway, to the intake end *a* of the rooms in question, and erecting there the brattice which had at first been unsuccessful, would try again to start the circulation through the rooms.

The conditions here presented form a very interesting study, as we reflect that it is just such conditions as these that frequently result in disastrous explosion. The men performing the work may often be willing to take greater risks than they have any moral right to do. In many cases, the removal of a body of gas is undertaken without the proper notification of the men affected; it being assumed that the accumulation of gas is small, and the matter is treated as one of little importance. The experience of many of our most trustworthy fire bosses is often such as would render them heroes, were they to be recorded; and yet they come so natural to these men, that they are often barely mentioned in their reports.

A fire boss should not be placed in charge of a larger territory than he can readily attend to. He should not be compelled to make undue haste in order to complete his rounds. He may, in such case, if not particularly conscientious, neglect certain places upon the assumption that they are clear of gas, and such neglect may be the price paid for many lives. Because any district is usually free of gas, in a mine where gas is known to exist in other districts, is no warrantable reason or excuse for the neglect to examine daily each and every place in such district. The examination must be thoroughly and carefully made. The fire boss should not be hurried in his movements, as it may often occur that he unconsciously passes under a considerable accumulation

of gas, and arrives at a point near the face from which he cannot beat a hasty retreat in safety, before becoming aware of the presence of a dangerous quantity of gas. This is altogether possible, under certain conditions, where the gas from a feeder at the face or in the roof has flowed along the roof for a considerable distance. The air in the room being quiet is comparatively free from any appreciable amount of gas as the fire boss enters, but the movement of his body as he advances along the airway causes eddies which mix the gas with the current. Not long since an occurrence of this nature took place in one of the mines of the anthracite district of Pennsylvania. The fire boss, a careful man, had proceeded a considerable distance toward the face of a chamber when he became aware of a considerable body of gas above him by the sudden flaming of his raised lamp. He lowered his lamp cautiously, but was unable to find a position

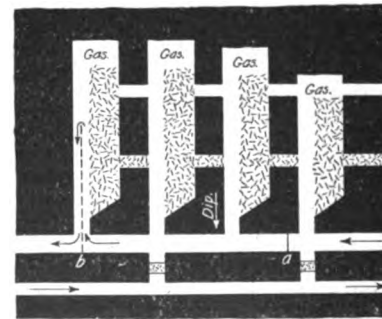


FIG. 1.

low enough where the flaming ceased, and realizing at once the urgency of his circumstances he smothered the lamp under his coat and started for the airway. This incident is only one of a thousand occurring daily in our mines, and illustrates very forcibly the fact that the movement of one's body, in passing through a narrow passage, will disturb a body of gas accumulated at the roof, and will cause it to mix in dangerous proportions with the air of the passageway. Under these circumstances, the fire boss often finds his retreat suddenly cut off when he is least aware that he has encountered danger. For this reason, it is all the more important that the work of the fire boss should not be hurried by the necessity of making his rounds within too small a limit of time. As before stated, it is such simple occurrences as these that afford us the many illustrations of unexplained disastrous explosions.

Quantity of Air Needed for Ventilation.

The quantity of air needed for the efficient ventilation of a coal mine is a subject concerning which there is a very great difference of opinion. The large number of mining accidents due to the lack of air supplied to the workings has made it necessary for legislators to enact very rigid laws in regard to this subject. These laws usually specify a minimum amount of air to be supplied to mine workings per minute. In respect to gaseous mines the law frequently goes further and specifies the number of men that shall be employed upon any one split of air, and also, frequently, the maximum velocity of the air, to be allowed at the face of the workings. It is right that the law should be thus specific in naming an actual amount of air to be maintained in ventilation. It is the duty of lawmakers to establish such regulations with respect to mine workings, as shall in their opinions make them safe under all conditions.

To any one acquainted with the very varying conditions of mines, however, there can be no specific and absolute amount of air, in cubic feet per minute, named which will be applicable in all cases, and very often the judgment of the mine inspector and of the mine operator has modified the amounts specified by law. There are some essential points to be observed which we must always bear in mind in the ventilation of the inner workings of a mine. First, the velocity of the current at the face should not be such as to render the workman uncomfortable. In a non-gaseous mine, the velocity of the air passing the face should not exceed 4 or 5 feet per second. There are often cases where a barely perceptible movement of air, at the face of the workings, is sufficient to maintain a pure and healthy atmosphere. Such cases are found where the development of the mine is small and the extent of abandoned workings is very limited. In gaseous mines, frequently, it is necessary to maintain a velocity which as nearly approaches the limit allowed by law as possible. This limit as specified in the Anthracite Mine Law of Pennsylvania, is $7\frac{1}{2}$ feet per second, or 450 feet per minute. It is necessary that this velocity be attained at the face of the workings as closely as may be, so as to enable the current to sweep away the gases which always accumulate in quantity at the face. If the velocity of the air falls much below this, some of the gas will still remain in the cavities of the workings, and will be a constant menace to the safety of the mine. With these facts before us, we see that the velocity of the air current sweeping the face of the workings is an essential point in all ventilation. Let us consider for a moment the conditions affecting the maintaining of this velocity.

(a) The thickness of the seams has very much to do in modifying the velocity of the current. At the face of the workings the air passages have a sectional area which is greater or less according to the thickness of the seam. Thick seams present a very large area for the passage of air, and a low velocity is the result; while thin seams present a small sectional area and the velocity is correspondingly high.

(b) The character of the roof and floor, and texture of the coal, inasmuch as they limit the width of the air passages, modify the velocity of the air current in the same manner. A poor roof, or soft bottom, or a frail coal, require narrow passageways, which present a small sectional area, and give a high velocity to the current; while strong roof, good bottom, and hard coal allow wider passageways, and a low velocity.

(c) The conditions, in a mine, which limit the number of splits that can be made in the current, also affect the velocity of the same; as the longer the split, in general, the larger the quantity of air required, and the higher its velocity.

Another essential feature of ventilation arises from the conditions relative to the amount of gas given off from the workings of a mine. Where much gas is given off, a larger current will be required in order to dilute those gases and render the same explosive. This evidently gives a very much larger volume of air than would be required for the use of men and animals, and for

the burning of the lamps, in the mines. The principal object, in this case, is the dilution of the gases. The amount necessary for this purpose can only be approximated as being proportional to the number of men employed or the extent of the working face.

Considering these several conditions which we have mentioned, and others relative to the temperature of the current and the ventilating pressure for the entire mine, as well as the amount of abandoned workings in the mine, which always gives rise to a large amount of carbonic-acid gas (blackdamp), we are brought face to face with the conclusion that the amount of air which should be supplied to any mine is really dependent upon conditions which can only be known to the men in charge of such workings. While the mine law must be carried out and enforced absolutely, it necessarily often imposes a condition which does not add to the comfort of the men. It, however, secures their safety and the general safety of mine workings. This is the purpose of the law. We have known instances where the miners at work upon a current of air that evidently fell below the requirements of the law, implored the inspector not to report the same, as they had a sufficient amount of air to render them healthy and comfortable, and they claimed further that any more air would "freeze them out." At another time, we knew a pit boss who had more education than veracity, and was evidently smarter than the inspector, who, knowing that the air was short in the main intake, followed the inspector into the airway; and, pretending interest in watching the instrument with which the air was being measured, interposed his body in the area of the airway, thereby giving a greater velocity to the air current at that point and securing a higher record for his mine than would otherwise have been obtained. The inspector did not notice the trick. We have known other inspectors who have been persuaded to measure the air upon the return current of the mine, and record the same as the air passing into the mine; perhaps never realizing that this return current, having a higher temperature and laden with the gases of the mine, presented a relatively larger volume than should have been recorded as entering the mine.

Rope Transmission in Mine Haulage.

There are a few general rules that must always be complied with in the installation of any rope haulage. Some of these rules are of particular importance in the application of rope haulage to mining.

Straight Haulways.—It is quite generally understood that any rope transmission should be planned in as straight and direct a manner as possible. The haulage roads in mines are often tortuous, and it would be a matter of considerable expense to make these roads straight. On the other hand, there is a great saving in expense, for maintenance of tracks and ropes, when the haulways can be made fairly straight. On this account, when rope haulage is installed upon a road that is at all tortuous, and this road is to be made the future main haulage road of the mine, it will often be a good investment to expend some money in the straightening of this road before installing the system.

Grades of Haulways.—If the road has numerous hills and swamps, giving short, varying grades, it will generally be practicable and advisable to cut the hills and fill the swamps, so as to render the grade of the new road fairly uniform. This is always done in the larger mines in laying out a main haulage road. There are two benefits arising from the establishment of a grade that is fairly uniform. (1) The load upon the winding engine is made more uniform. (2) There is a very considerable reduction in the wear and tear upon the rope. When a haulage rope crosses a hill, it bears heavily upon the carrying rollers placed in the middle of the track. This often causes a rapid wear of the wooden rollers, necessitating their being replaced frequently, and there is always an increased wear upon the rope. This trouble, however, upon the hills, is not as great as what occurs where the rope crosses a sag in the road, or what is termed in mining, a "swamp." At this point, the rope is lifted clear of the carrying rollers, and jumps violently up and down by reason of the varying tension caused by the loaded trip. At such points of a haulage road, we have seen the main rope of the loaded trip vibrating from top to bottom, and from side to side of the entry, rendering the passageway unsafe for any one whose duties might call him hither. The consequent wear and tear upon the rope under such conditions is enormous, and no one would hesitate to make a considerable outlay in order to avoid the trouble. There should be no sudden change of grade at the foot of an incline. The change of grade should be so moderate that the weight of the rope will prevent its being lifted too high off the rollers. It is generally possible to obtain this result by using a little judgment and foresight in the arrangement of the grades.

Rollers and Carrying Sheaves.—The location of the rollers and carrying sheaves for any haulage rope should be such that the rope will bear continuously and regularly upon the rollers as far

as practicable. There are various forms of rollers and carrying sheaves in use. When the rope lies in the center of the track it is commonly carried by a small wooden roller (Fig. 1) of say 5 inches in diameter, and from 12 to 18 inches in length. These are usually turned from oak or other hard wood, and fitted with a short iron rod inserted into the center of each end as a journal or bearing. When the rope is carried along the side of the haulway, cast-iron sheaves (Fig. 2) are often employed, having a diameter varying from 10 to 16 inches, the faces of the sheave being often chilled to increase their wear. These rollers should always be set so that their alignment is true. Wherever there is a deflection of the rope, the carrying sheave should be inclined so as to lie exactly in the plane of the deflected rope. This rule is very important. Track rollers are usually spaced from 5 to 8 yards apart. Carrying sheaves along the sides of the roadway are placed at convenient points, varying from 10 to 20 yards apart. At times, the rope is carried over the haulway, ordinary track rollers being hung from the collars or framing sets. Rollers and carrying sheaves are usually mounted in wooden bearings made by boring a hole in a piece of oak of suitable thickness. These bearings are kept well oiled.

Guide Sheaves.—Guide sheaves are necessary wherever the rope is carried around a curve, or changes its direction. Numerous forms of guide sheaves are employed, but these are usually arranged according to two general systems. Whenever a haulage rope is deflected through a certain angle it must be (1) carried around a grooved sheave of sufficient diameter as not to injure the rope by bending; or (2) numerous small sheaves or rollers must be employed, spaced at regular distances apart, and so arranged that their centers shall lie in the arc of a circle. The first arrangement is usually employed where the tail rope is deflected through a considerable angle in the mine, as, for example, where the rope passes from a main heading to a crossheading. The sheave used in this case is a large cast-iron grooved sheave similar to those employed at the top of headframes for hoisting, but is placed in a horizontal position. The groove is usually lined with oak blocks the same as in hoisting sheaves. The second arrangement is employed where the main rope is carried around a curve in the haulage road. The main rope must of necessity conform to the track; and when the direction of the roadway changes, guide sheaves are necessary in order to deflect the rope. The simplest form of guide sheave employed is that shown in Fig. 3. This form is used where only a slight change occurs in the direction of the track. This is the same form of roller as shown in Fig. 1, made shorter and set upright. An iron strap is usually employed, as shown in the figure, to supply the upper bearing.

The form of roller shown in Fig. 4 is often used around a curve, and is placed at the side of the track, outside of the inner rail of the curve. These rollers are often slightly inclined from the vertical. They are made of cast iron, chilled or case hardened. The flange is set upward, and is for the purpose of preventing the rope from traveling higher upon the roller. These rollers are usually spaced from 2 to 3 feet apart around the curve. Another form of guide sheave used in conveying the rope around the curve in the track, is that shown in Fig. 5. This form consists of a carrying sheave, the same as shown in Fig. 2, but placed in a horizontal position.

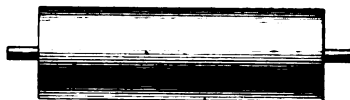


FIG. 1.

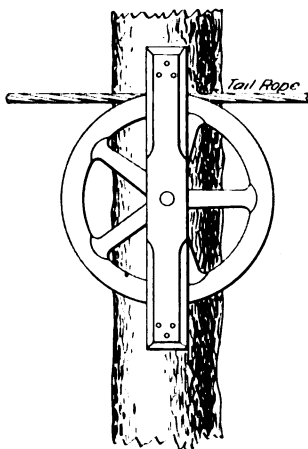


FIG. 2.

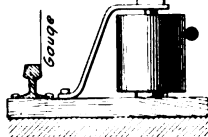


FIG. 3.

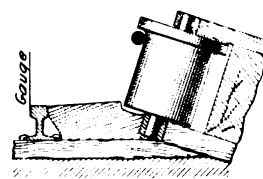


FIG. 4.

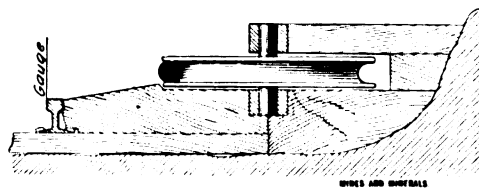


FIG. 5.

of the bending stress. Thus, to obtain the bending stress for a rope of a given diameter, passing over any given sheave, we may multiply the ratio of the diameter of the rope to the diameter of sheave by the ratio given above for the size of rope used, which will give the ratio of the diameter of the wire to the diameter of

the sheave $\left(\frac{d}{D}\right)$; and substitute this value in the expression for

the bending stress, $E \frac{d}{D}$. For example, suppose a 1-inch rope passes over a sheave 8 feet in diameter, the rope being a 7-wire rope, the bending stress in this case will be

$$26,000,000 \times \frac{1}{8} \times \frac{1}{12} \times \frac{1}{7} = 30,000 \text{ lb. per sq. in.}$$

This rope having six strands contains $6 \times 7 = 42$ wires, whose diameters are each, approximately, $\frac{1}{4}$ inch. The area of cross-section for these wires will therefore be $42 \times .7854 \times \left(\frac{1}{4}\right)^2 = .4167$ square inch. Multiplying this area of cross-section by the stress per square inch (30,000 lb.), we obtain for the bending stress $.4167 \times 30,000 =$ say 12,500 pounds, or 6.25 tons. This means that the rope, in its passage over the sheave, is subjected to a bending stress in its outer wires, equivalent to an additional load of 6.25 tons

tion. These sheaves are arranged at equal distances outside of the inner rail, and at regular intervals apart, all the way around the inside of the curve. At each roller or sheave in Figs. 4 and 5, and at suitable intervals between them, oak blocks are arranged for the purpose of allowing the rope to slide into position in the groove of the carrying sheaves, and to prevent its catching in the rail as the trip goes around the curve.

Bending Stress in Ropes.—It is a well known fact that, when a wire rope is bent through a certain angle, the stress in the outer fibers is greater than that of the inner fibers of the rope. When the angle of bending is too great at any one point, the rope is permanently injured. The bending stress in a rope, or the stress due to the bending of a rope around a given sheave, is calculated for the outside fiber of the rope, or for a single wire of the rope lying outermost in the curve, since it is this wire that is subjected to the greatest bending stress. The bending stress in pounds per square inch to which the outer wire of a rope is thus subjected is

given by the expression $E \frac{d}{D}$, in which E = modulus of elasticity

(for steel, $E = 26,000,000$); d = diameter of a single wire of the rope (inches); D = diameter of sheave (inches). The bending stress obtained by this formula is the stress in pounds, per square inch, exerted upon the outermost wire of the rope. Since, however, previous to bending over the sheave, each wire of the rope

carries its proportion of the actual load, the bending stress should be calculated for all the wires of the rope, or the entire sectional area of wire in the rope, and this load due to bending, or the bending stress added to the actual load carried by the rope. This is the true load upon the rope, because the strength of a rope is determined by the strength of its ultimate fiber.

The fact that the ratio of the diameter of the wire to the diameter of the rope is for 7-wire ropes $\frac{1}{7}$, for 12-wire ropes $\frac{1}{12}$, and for 19-wire ropes $\frac{1}{19}$, approximately, may simplify the calculation

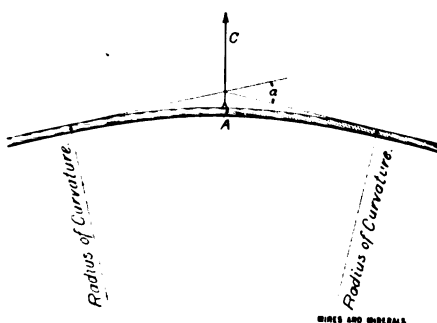


FIG. 6.

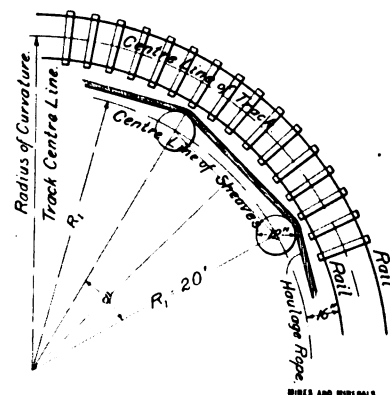


FIG. 7.

upon the rope. The proper working load allowed for this rope, as taken from catalogue of makers, is 8.4 tons. Subtracting the bending stress calculated above, we have $8.4 - 6.25 = 2.15$ tons, actual net load that should be allowed upon the rope.

TABLE I.

SHOWING DIAMETERS OF MINIMUM SHEAVES FOR STEEL AND IRON ROPES OF DIFFERENT SIZES AND KINDS.

Diameter of Rope (Inches).	Steel Rope, 6 Strands.			Iron Rope, 6 Strands.		
	7-Wire (Inches).	12-Wire (Inches).	19-Wire (Inches).	7-Wire (Inches).	12-Wire (Inches).	19-Wire (Inches).
1/16	19	14	12	40	30	24
1/8	24	18	14	50	38	30
3/16	29	22	17	60	45	36
1/4	34	25	20	70	53	42
5/16	38	29	23	80	60	48
3/8	43	32	26	90	68	54
7/16	48	36	29	100	75	60
1/2	53	40	32	110	83	66
5/8	58	43	35	120	90	72
3/4	67	50	40	140	105	84
7/8	77	57	46	160	120	96
1	87	64	52	180	135	108
1 1/8	98	72	58	200	150	120
1 1/4	109	80	64	225	170	135
1 1/2	120	88	71	250	190	150

Since the breaking strain of this rope is 42 tons, if the rope were to be loaded with a net load equal to its full working capacity (8.4 tons), the total load upon the rope, including bending stress at the sheave, would be $8.4 + 6.25 = 14.65$ tons; and there would result only a factor of safety of $\frac{42}{14.65} = 3$, nearly. These conditions, however, or the loads just calculated, are the ultimate loads

Table I showing the minimum diameter of sheave in inches, required for steel and iron ropes of various diameters, as taken from the Trenton Iron Co.'s "Wire Rope Transportation." This table, it will be noticed, differs from previous tables, which were revised as the quality of the ropes were improved. The table has been extended beyond that given in the catalogue, to include ropes of $1\frac{1}{8}$, $1\frac{1}{4}$, $1\frac{1}{2}$, and $1\frac{3}{4}$ inches in diameter.

Table No. I has reference only to the minimum sizes of sheaves permissible, where the rope is so loaded and deflected through such an angle that its curvature is the same as the curvature of the sheave. Where a rope transmitting power passes over a sheave and is deflected through a given angle, the rope does not necessarily conform to the curvature of the sheave. To make this plain and to understand more clearly what follows, we will refer to Fig. 8, which represents a wire rope deflected through a small angle α , by a cord C tied to it at A. We observe at once that the rope, on account of its rigidity, does not bend in a sharp angle at the point where the string is tied, but assumes a gradual curvature. The radius of this curvature is dependent upon several factors. (1) The tension upon the rope or the pull upon each end. (2) The angle of deflection or angle of bending. (3) The rigidity of the rope. The first two factors mentioned are easily assumed, for any given case; the third factor is more or less indeterminate, since an old rope, or one in use for a considerable period of time, has not the rigidity possessed by a new rope. The only method of comparison that can be made must be based, however, upon new ropes, since old ropes may have any varying amount of rigidity. We give below a table slightly modified from the table found in The Trenton Iron Co.'s "Wire Rope Transportation," previously referred to, and which shows the radius of curvature in inches, for a new rope, for different angles of deflection varying from 5° to 90° and different diameters of rope.

The radii of curvature given in this table are expressed in inches, and are for a tension of 1 pound upon the rope. These

TABLE II.

SHOWING THE RADIUS OF CURVATURE IN INCHES OF NEW STEEL 7-WIRE AND 19-WIRE ROPES OF DIFFERENT DIAMETERS, HAVING A LOAD OF ONE POUND UPON THE ROPE AND HAVING AN ANGLE OF DEFLECTION OF THE ROPE VARYING FROM 5° TO 90° .

Diameter of Rope (Inches).	Angle of Deflection of Rope.														
	7-Wire Rope.														
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	70°	80°	90°
1/16	51,406	25,727	17,179	12,914	10,360	8,663	7,457	6,556	5,859	5,308	4,856	4,485	3,908	3,488	3,171
1/8	118,482	59,297	39,594	29,762	23,878	19,968	17,187	15,111	13,505	12,229	11,193	10,336	9,010	8,040	7,309
3/16	248,066	124,151	82,899	62,313	49,993	41,807	35,984	31,637	28,275	25,604	23,434	21,641	18,865	16,834	15,302
1/4	462,745	231,598	154,641	116,239	93,258	77,988	67,124	59,016	52,745	47,761	43,714	40,277	35,191	31,402	28,545
5/16	793,500	397,129	265,173	199,823	159,915	133,731	115,103	101,199	90,446	81,899	74,959	69,224	60,344	53,847	48,949
3/8	1,276,131	638,674	426,459	320,556	257,180	215,069	185,111	162,751	145,457	131,712	120,551	111,828	97,047	86,598	78,721
1/2	2,008,017	1,004,985	671,041	504,402	404,679	338,416	291,276	256,092	228,880	207,252	189,689	175,177	152,706	136,263	123,869
Diameter of Rope (Inches).	19-Wire Rope.														
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	70°	80°	90°
	16,825	8,421	5,623	4,226	3,391	2,836	2,441	2,146	1,918	1,736	1,626	1,484	1,240	1,142	1,038
1/16	44,178	22,095	14,758	11,090	8,897	7,440	6,404	5,630	5,032	4,546	4,170	3,851	3,357	2,996	2,728
1/8	88,673	45,412	29,683	22,274	17,870	14,944	12,863	11,309	10,107	9,151	8,377	7,736	6,743	6,017	5,470
3/16	171,917	86,040	57,451	43,184	34,647	28,974	24,938	21,925	19,59	17,742	16,240	14,998	13,074	11,666	10,605
1/4	285,897	143,085	95,541	71,816	57,617	48,181	41,471	36,462	32,547	29,506	27,007	24,941	21,742	19,401	17,636
5/16	448,907	224,667	150,016	112,763	90,469	75,655	65,117	57,251	51,168	46,329	42,406	39,162	34,138	30,463	27,892
3/8	678,328	339,982	225,012	169,135	135,696	113,477	97,670	85,872	76,747	69,489	63,606	58,740	51,205	45,692	41,585

to which the rope is subjected. Attention is drawn here to the load due to bending, as being included in the "Proper Working Load" for a rope, and allowance must always be made for this when determining the size of rope required. In practice, the factor of safety varies from 3 to 10, according to the importance of the rope and the magnitude of the accident that would result from its breaking. The factor of safety for inclines should not be less than 6, while a factor of safety of 3 would be sufficient often for flat roads.

Size of Sheave.—Since the bending stress in the rope increases as the diameter of the sheave decreases, there is a practical limit to the size of sheave that should be employed with different sizes of ropes. It is common practice, in the use of steel ropes for haulage purposes, to employ sheaves whose diameter is not less than 80 times the diameter of the rope. This rule refers only to haulage ropes made of six strands with seven wires in each strand. In the use of steel ropes of 12 wires, the diameter of the sheave should not be less than 60 times the diameter of the rope. Steel ropes of 19 wires (hoisting ropes) require sheaves whose diameter is not less than 50 times the diameter of the rope. In the use of iron ropes, these ratios are doubled; in other words, an iron wire rope of the same number of wires requires a sheave having double the diameter of that employed for a steel rope. We give here

radii must in each case be divided by the actual tension or load upon the rope in question, since the radius of curvature varies inversely as the tension upon the rope, for the same angle of bending.

This table has a very interesting application in the practice of wire-rope transmission. When the angle of deflection of a rope is small, or when the angle is considerable and the rope is not heavily loaded, a smaller sheave than that specified as a minimum sheave for this rope may be employed without damage to the rope; for the reason that owing to the rigidity of the rope the radius of curvature of the rope is not the same as the radius of the sheave. For example, a new 1-inch 7-wire haulage rope loaded to only one-half ton (1,000 lb.) would, according to the data furnished us in Table II assume a curvature whose radius is $48,949 =$ say 49 inches when deflected through an angle of 90° .

$1,000$ This corresponds to a diameter of $49 \times 2 = 98$ inches. Under this load and for this angle of deflection, a new rope would not conform to the curvature of a sheave whose diameter was less than 98 inches, and therefore a smaller sheave than this should not be used for this load.

The most interesting application, however, lies in the problem of carrying a haulage rope around a curve in the roadway. In

this case, small sheaves must be employed, set side by side at given distances around the curve (see Fig. 7). If it were true that, however small the angle of contact upon the sheave, the rope partook of the curvature of the sheave and was thereby damaged when passing over a small sheave, it would not be possible to carry a haulage rope around the curve in a track without damage, except at great inconvenience growing out of the employment of sheaves of very large diameter. Since, however, a rope assumes its own curvature, depending upon the load it carries and the angle of deflection, it is possible to set small sheaves at such distance apart around the curve in the track as to reduce the angle of bending (a) at each sheave so that the curvature of the rope will be less than that of the minimum amount given in Table I. For any given curvature of track the angle of deflection at each sheave is smaller as the sheaves are closer together.

Calculation of Distance Apart of Guide Sheaves Around Curves. There are two previous steps in the calculation of this problem. (a) To determine the radius of curvature for the rope in question, for a load of 1 pound upon the rope. (b) To determine the angle of deflection at which this rope will assume this radius, under a load of 1 pound.

(a) To calculate the radius of curvature permissible for a load of 1 pound, we use the formula

$$R = .7854 \frac{E n d^3}{2}, \quad (1)$$

in which R = radius of curvature of the rope (inches);

E = modulus of elasticity (steel, 26,000,000 to 32,000,000, say 28,000,000; iron, 22,000,000);

n = number of wires in the rope;

d = diameter of single wire (inches).

When the rope is made of wires of different diameters, the entire sectional area of wire in the rope, $n(.7854 d^2) = A$, is estimated separately, and the formula then becomes

$$R = \frac{E A d}{2}, \quad (2)$$

in which A = entire sectional area of wire in the rope (sq. in.);
 d = diameter of outer wire (inches).

(b) Having calculated the radius of curvature, observe from Table II the angle of deflection that corresponds to the radius

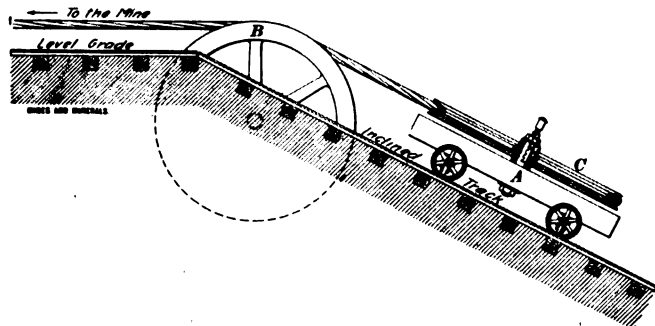


FIG. 1.

next higher, and assume this angle as the angle of bending at each sheave supporting the rope around the curve.

Having determined the angle of bending at each sheave, we have the angle of deflection for the track curve between two consecutive sheaves. We then subtract from the radius of curvature of track center the distance from the center of the track to the line of the sheaves to obtain the radius R_1 (Fig. 7). Then applying geometry, we have

$$s = 2 R_1 \sin \frac{1}{2} a, \quad (3)$$

in which, s = distance between the centers of guide sheaves (feet);

R = radius of center line of sheaves (feet);

a = angle of bending or deflection of rope at each sheave.

EXAMPLE.—A 1-inch 7-wire steel haulage rope is to be carried around a curve in a track. The radius of the track center curve is 50 feet, and the guide sheaves are set with their centers 3 feet from the track center. What is the proper distance between the centers of the guide sheaves?

SOLUTION.—Substituting values in formula (1), remembering that, as there are six strands with seven wires in each strand, $n = 6 \times 7 = 42$ wires, and since the ratio of the diameter of the wire to the diameter of the rope is, approximately, $\frac{1}{4}$ for 7-wire ropes, we have for the permissible radius of curvature of this rope, for a load of 1 pound,

$$R = \frac{.7854 \times 28,000,000 \times 42 \times \frac{1}{64}}{2 \times 9^2} = 633,500 \text{ in.}$$

Referring now to Table II, we observe that the next higher radius for a 1-inch 7-wire rope is 793,500, and this corresponds to a deflection angle of 5° . We therefore will assume this angle as the angle of bending of the rope at each sheave, or the angle (a) between the radii drawn to two consecutive sheaves. Finally, substituting in formula (3), we have

$$s = 2(50 - 3) \sin 2^\circ 30' = 94 \times .04362 = 4.10 \text{ ft.}$$

Haulage.

(Continued from August.)

The Endless-Rope System of Haulage.—As has been previously mentioned, this system of haulage is better adapted to seams which present a fairly uniform grade throughout the entire length of the roadway. The reason for this is found in the fact that where the grades are short and variable, a varying load will be thrust upon the winding engine, if the moving cars are distributed along the entire length of the roadway. This is more particularly the case when the cars forming the several individual trips are not spaced at regular intervals along the rope, which is a common occurrence in mine haulage. The numerous occurring delays both in the delivery of cars by the inside drivers at the parting where the trips are made up, as well as the delays incident to loading, at the tippie render it practically impossible that the several trips shall be regularly spaced. There is, in fact, no regularity in regard to the distance between the trips for empty or loaded cars. As a result, many of the loaded trips may be on an ascending grade at the same time; or they may all likewise reach a descending grade at once. This will render the load upon the engine very irregular and often very hard to control, especially if the engine is worked already to a point approaching its capacity.

The most of the details in relation to the conducting of a haulage rope into and through the mine passages, have been already described in previous articles. In this article we will refer to and describe only those details that have particular reference to the endless-rope system of haulage.

The Winding Drum.—The winding drum in the endless-rope system is very different from that employed in a tail-rope system. Here, the rope being an endless rope, is made to pass two or three times around the drum and then winds off. Only such a number of coils are made around the drum as will provide the friction necessary to prevent slipping of the rope. The number of coils required for this purpose will depend upon the pull of the rope, which varies according to the length of the haulage, the grade of the road, the load being hauled, etc. It is not necessary for this purpose that the drum should be a long drum, as is required in the tail-rope system. A difficulty arises, however, in regard to the fleeting of the rope along the face of the drum where a single drum or sheave is used.

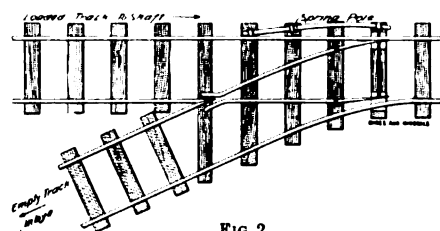


FIG. 2.

This difficulty has been referred to, and the best method of overcoming it described, in an article, page 524, MINES AND MINERALS, June, 1900. Driving sheaves having a single groove are sometimes used in place of drums, in the endless-rope system where the haulage is light; but a large amount of wear upon the rope always takes place in their use, and for this reason they are not to be recommended. In their place have been substituted two drums, arranged tandem to each other, each drum having three or four grooves upon its face, according to the number of coils the rope is required to make about the drum. In the use of these tandem drums, the wear upon the rope is reduced to a minimum, the rope making a half coil upon each drum and passing to a different groove for each coil that it makes.

Balance Car.—One of the difficulties to be overcome in the operation of the endless-rope system that is not met in the other systems, arises from the fact that the rope, being an endless rope, requires some appliance for taking up the elongation of the rope due either to change of temperature or to the stretch of a long rope. The simplest appliance introduced for this purpose is that of the balance car. This is represented in Fig. 1. Its location is usually outside of the mine at some convenient point in the rear of the engine. The rope winding off from the drum passes directly around the large sheave C mounted upon the balance car A , and from thence is conducted into the mine. The rope on its way to and from the balance car passes over the large deflecting sheave B . The position of the balance car is thus seen to be at the outer end of the empty rope, or the rope which draws the empty cars back into the mines. The haulage rope is one continuous rope

running in and running out of the mine; but it is proper to speak of the ingoing and outgoing sections as the empty and loaded ropes, respectively. As shown in the illustration, the balance car *A* rests upon a short plane of a fixed inclination. The weight of the car should be such as is found necessary to keep the empty rope taut. As the rope stretches or as its length varies, due to changes of temperature, the balance car falls or rises upon the inclined track. If there is a tendency of the rope to slip upon the winding drum of the engine, this may be overcome by increasing the weight in the balance car.

Roadway.—In this system of haulage there is of necessity a double track, one for the loads and one for the empty cars. At times these tracks are laid in the same entry, but this requires a good roof and floor throughout the entire length of the road. These conditions are seldom found in mining, on which account the loaded and empty tracks usually occupy different passageways.

In some few instances single tracks are used in the operation of the endless-rope system, passing tracks being arranged at intervals along the road. In such cases it is necessary to have trip riders to ensure that each trip takes its proper siding and waits at that point until the trip passes it going in the opposite direction. When this arrangement is adopted the trips usually consist of several cars. If there were a certainty in regard to the spacing of the cars at regular intervals along the rope, the trip riders could be dispensed with by using automatic switches at each end of the parting or passing tracks; but this system would require numerous track walkers whose duty it would be to see that everything was moving smoothly, although it is often claimed by careful engineers that they can at once detect when anything is wrong below by the action of the rope and the engine. The automatic switch is a switch having a spring latch that is kept set for the empty track upon the outbye end, and for the loaded track upon the inbye end of the parting. This switch is shown in Fig. 2. The spring of the latch is furnished by a simple spring-pole spiked to the ties outside of the rail. There is nothing in the single track system, however, that recommends itself for the operation of this type of haulage.

Grips.—There are several forms of these in use for attaching

the car to the rope. Two features present themselves for consideration in relation to the cable grip, in endless-rope haulage. These are: (a) The constant motion of the rope. (b) The inertia of the load. The chief difficulty arises in providing a grip that will impart the motion of the rope to the standing cars without causing undue abrasion of the rope. The rope running at a uniform velocity and the cars being at rest, much injury will be caused to the rope by a grip that is not designed to prevent the undue wear of the rope. The simplest form of grip in use is the common type known as "grip tongs," shown in Fig. 3. This style of grip is very hard upon the rope; especially if the jaws of the grip are not lined, as they should be, with soft metal. The metal lining is readily replaced when worn, and saves the rope from wear to a large extent. When several cars coupled together are run in a single trip, the form of the grip must be such as to give a greater pressure, as the common grip tongs will slip, from time to time, and do much damage to the rope. Such a form of grip is shown in Fig. 4. It consists of two strong steel plates *m* and *n*, bolted together, one of these supporting the lower jaw *p* of the grip. The upper jaw is provided with a shank that slides up and down between the plates. This shank is operated by the eccentric motion of the lever *r*. When this lever is raised to an upright position, the upper jaw of the grip is lifted; when the lever is thrown down, the cable is pressed very strongly between the jaws. The jaws of the grip are lined with soft metal to prevent the undue wear of the rope.

Grips are often attached to the mine car directly, such forms being made detachable. When many cars are run in a trip, it is customary to have what is known as the grip car, which is a simple platform truck carrying a substantial grip beneath it. The trip rider who operates the grip rides upon this car. The grip, which is usually of the form shown in Fig. 4, is provided with a

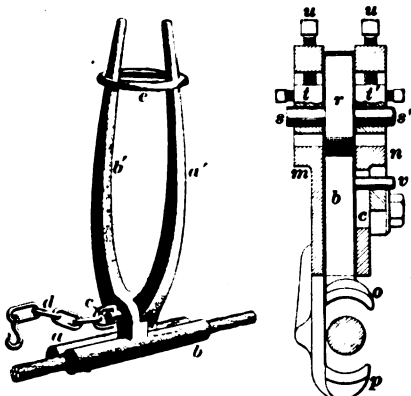


FIG. 3.

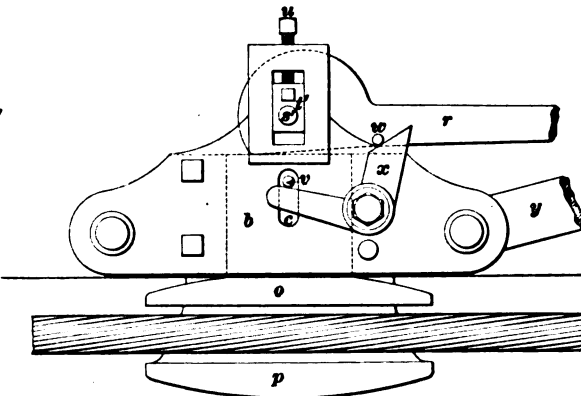


FIG. 4.

sidelong motion that enables it to pass the guide sheaves, located at different points along the track.

District Haulage.—In the development of a mine, it often becomes necessary to extend the haulage rope, in more than one direction; as for example, when several pairs of cross-entries cover too large a territory to admit of mule haulage. There are two methods possible in such a case. The first of these methods is to carry the main rope into each cross-entry and passing it over a tail sheave return it to the main entry again, where it pursues its original course. The same rope runs in each pair of cross-entries and performs the entire haulage of the mine. This method has numerous disadvantages. It entails the constant running of the ropes, in all the districts of the mine, which means a considerable loss of power. A break in any one district affects the haulage system of the entire mine; and haulage must cease until such break is repaired. The better plan is to perform the haulage in each district by a separate rope. In this method, a fleet wheel is located in the main road at the mouth of each district, and the main rope makes one or two complete turns around this wheel, and then continues on its course along the main road. The fleet wheel at the mouth of each district furnishes the motive power for running the rope in that district. It is connected with the driving sheave for the district, by means of two beveled gears. In Fig. 5, the fleet wheel is shown at *d*, the beveled gears at *g* and *h*, and the driving sheave for the district at *m*. The driving sheave may be thrown in or out of gear, as desired, by the levers *o* and *q*. This permits the running of the rope in any district, as it is required; and when not in use, the district rope may be thrown out of gear. It will be observed that both the fleet wheel and the driving sheave, for any district are simple grooved sheaves, which gives rise to a considerable wearing of the haulage rope, as was explained in a previous paragraph, in relation to winding sheaves of this form being employed instead of tandem drums at the engine.

CALCULATION OF POWER REQUIRED FOR ENDLESS-ROPE HAULAGE.

(a) **Flat Seams.**—The conditions here vary from the conditions in tail-rope haulage. (1) Whether the opening is a shaft or slope

opening, the weight of the descending rope always balances the weight of the ascending rope. (2) Whatever the variations of grade along the line of haulage in the endless-rope system, these may be neglected, as the load upon the rope is assumed to be distributed along its entire length. In the tail-rope system of haulage, the entire load

must at some time be concentrated upon the steepest grade in the road. It is true that circumstances may occur when the most of the loads, in the endless-rope system, will be either ascending or descending a grade at once. For this reason it is not advisable to adopt this system, when the grades are variable, as previously stated; but if these conditions exist, in the operation of this system, ample allowance must be made when calculating the power of the engine, to provide against such untoward conditions.

For endless-rope haulage, in flat seams, ignoring variations in grade, the load upon the rope at the engine, is equal to the friction pull of the entire system. To determine this, we must know the entire output, speed of winding, length of haulage road, and the capacity and weight of the mine cars; and must find therefrom the size of rope required, since the friction of the rope must be added to the friction of the cars, in calculating the load upon the engine.

Let

- O = output (lb. per min.);
- v = speed of winding (ft. per min.);
- l = length of haulage road (ft.);
- c = capacity of mine car (lb.);
- w_1 = weight of mine car (lb.);
- w = weight of rope per lineal foot (lb.);
- T = load on the rope (lb.).

$$\text{Then, } \frac{1}{v} O = \text{weight of coal in transit; } \frac{2}{v} \frac{O}{c} \times w_1 = \text{weight of}$$

moving cars, loaded and empty; $2lw$ = weight of entire rope; $\frac{lO}{v} \left(1 + \frac{2w_1}{c}\right) + 2wl$ = entire moving load.

Calling the coefficient of rolling friction $\frac{1}{c}$ of the weight of the moving load, we have for the load on the rope, which in this case is the friction pull only,

$$T = \frac{1}{40} \left[\frac{lO}{v} \left(1 + \frac{2w_1}{c}\right) + 2wl \right].$$

Multiplying the load or pull on the rope by the velocity of the rope or speed of winding v and dividing by 33,000, we have finally for the horsepower required for this haulage,

$$\text{H. P.} = \frac{l}{40 \times 33,000} \left[O \left(1 + \frac{2w_1}{c}\right) + 2wv \right].$$

EXAMPLE.—Let it be required to find the horsepower necessary for an output of 1,000 tons per day (10 hours) where the endless-rope system is employed; the length of the haulage being 5,000 feet from the return sheave to the bottom of the shaft, the seam being generally flat and having a thickness of 5 feet.

SOLUTION.—We will assume in this case that the height of the haulage road is $5\frac{1}{2}$ feet, in the clear above the rail, and that the mine cars have a capacity of 2,000 pounds of coal, and weigh 1,200 pounds each. We will assume a speed of winding of, say 8 miles per hour, or $\frac{8 \times 5,280}{60} = 704$ feet per minute. For the output in

this case we have, $O = \frac{1,000 \times 2,000}{10 \times 60} = 3,333$ lb. per min.

Size of Rope.—Substituting the given values, in the above formula to find the load upon the rope, assuming for the purpose of calculation a one-inch rope, whence $w = 1.58$, we have

$$T = \frac{1}{40} \left[\frac{5,000 \times 3,333}{704} \left(1 + \frac{2 \times 1,200}{2,000}\right) + 2 \times 1.58 \times 5,000 \right] = 1,697, \text{ say } 1,700 \text{ lb.}$$

We observe we could use a much smaller rope, in this case, than a one-inch rope, if we considered the load only; but in haulage the wear upon the rope is often a more important factor than the load, in determining the size of rope to be used. For this haulage we would prefer not to use a smaller rope than the one assumed above.

Horsepower of Engine.—Substituting the given values, in the formula given above for determining the horsepower of this haulage, we have,

$$\text{H. P.} = \frac{5,000}{40 \times 33,000} \left[3,333 \left(1 + \frac{2 \times 1,200}{2,000}\right) + 2 \times 1.58 \times 704 \right] = 36.2 \text{ h. p.}$$

Then, assuming the efficiency of the engine as, say 60%, we have $\frac{36.2}{.60} = 60$ total horsepower of engine.

Size of Drum.—Using a one-inch rope, we will employ a drum having a diameter of, say 80 inches, since the minimum diameter of sheave for this rope is about 77 inches. A winding speed of 704 feet per minute will require $\frac{704 \times 12}{3.1416 \times 80} = 33.62$ revolutions of drum per minute.

Size of Engine.—For this horsepower (60 h. p.) we may assume a speed of, say $n = 350$ strokes per minute. We will adopt a duplex engine, running upon second motion, under a mean effective cylinder pressure of 60 pounds per square inch. Assuming the ratio of the length of stroke to the diameter of the cylinder, $r = \frac{l}{d} = 1.5$, and using the formula given upon page 569,

MINES AND MINERALS, July, 1900, we have for the diameter of the cylinder

$$d = \sqrt[3]{\frac{60 \times 33,000 \times 12}{.7854 \times 60 \times 1.5 \times 350}} = 9.866 \text{ in., say } 10 \text{ in.}$$

Length of stroke = $9.866 \times 1.5 = 14.8$ in., say 15 in.

The engine for this haulage is, therefore, a duplex second motion engine, 10" × 15".

Ratio of Gearing.—The ratio of gearing, $r_1 = \frac{\text{diam. of gear wheel}}{\text{diam. of pinion}}$,

when we have given the diameter of the drum D , in inches; speed of winding v , in feet per minute; and the strokes per minute of the engine n , is obtained as follows:

$$r_1 = \frac{\pi D n}{2 \times 12 \times v} = \frac{3.1416 \times 80 \times 350}{2 \times 12 \times 704} = 5.2.$$

That is to say, for every 10 teeth in the pinion upon the crank shaft, there must be 52 teeth in the gear wheel upon the drum.

(b) **Inclined Seams.**—Under this head, is included any system of endless-rope haulage where the load is lifted through a given

vertical height. This may apply to haulage in a flat seam which is reached by a rock slope; or to haulage in seams having a general inclination or dip from the foot of a shaft, inbye. The calculation of power, in this case, is the same as that in the previous case (a), except that the work Oh must be added, or the work due to lifting the coal ($O =$ output per minute) through a given vertical height h . The weight of the cars and rope is always assumed to be balanced; but as previously mentioned in the endless-rope system, when the grade of the haulage road is variable, ample allowance must be made to provide for emergencies which arise when there are delays.

The grade of the roadway, where this is considerable, will increase the tension or pull upon the rope, by the gravity pull due to the weight of the rope and the loaded cars, or as many of them as can occupy the grade at one time. The load upon the engine, however, will only be increased by the gravity pull due to the unbalanced load or output on the grade.

For purposes of calculation, it is simpler to estimate the additional work to be performed per minute due to the grade of the incline, for the elevation h , by means of the expression Oh . The total work per minute u will then be expressed as follows:

$$u = \frac{l}{40} \left[O \left(1 + \frac{2w_1}{c}\right) + 2wv \right] + Oh.$$

Assuming the same conditions as given in the previous example (a), except that in the entire length of the haulage there is a general elevation or rise of, say 100 feet, we may apply this formula to determine the effective work per minute performed in such haulage. It is to be observed that the elevation or rise h may occur from the general dip of the haulage road from the shaft bottom, inbye; or it may all occur in the slope, at the end of the haulage road, as when a flat seam is opened by a rock slope; or it may occur at any other point in the haulage road. The method of calculation will be the same in each case.

The change of grade from a level roadway to a rise, must never be so abrupt that the weight of the rope and the loaded cars, spaced at regular intervals, will not cause the rope to lie upon the rollers. The rope may lift from the rollers slightly between the cars or trips; but there should be no tendency to lift the empty cars from the track.

Assuming the above conditions we have for the effective work of the engine per minute, in this case,

$$u = \frac{5,000}{40} \left[3,333 \left(1 + \frac{2 \times 1,200}{2,000}\right) + 2 \times 1.58 \times 704 \right] + 3,333 \times 100 = 1,528,050 \text{ foot-pounds per minute} = 46.3 \text{ h. p.}$$

If we assume the efficiency of the engine as 60%, we have $\frac{46.3}{.60} = 77$ total horsepower of engine.

For the size of engine, in this case, assuming as before a duplex, second-motion engine, with steam pressure at 60 pounds per square inch, we have

$$d = \sqrt[3]{\frac{77 \times 33,000 \times 12}{.7854 \times 60 \times 1.5 \times 350}} = 10.72 \text{ in.}$$

Length of stroke = $10.72 \times 1.5 = 16.08$ in.

The size of the engine for this case is, therefore, 10½" × 16".

The production and consumption of coal is so closely associated with that of pig iron, and of manufactured iron and steel, that it is worth while to note what effect the record for 1899, made by these commodities, will have upon the total mineral production for 1899. The production of pig iron in 1899, was 13,700,000 long tons, against 11,773,934 long tons in 1898. The average price for pig iron in 1899 was about \$18 per ton, making the total value about \$246,600,000 against \$116,557,000 in 1898 when the average price was less than \$10 per ton. This makes an increase of \$130,000,000, and the increase of \$51,000,000, in the value of the coal product makes a total increase of \$181,000,000, which without any increase in the other mineral production would make the total value of the mineral products in 1899 about \$860,000,000.—United States Geological Survey.

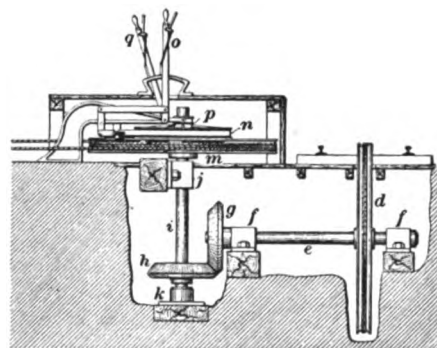


FIG. 5.

NEW INVENTIONS.

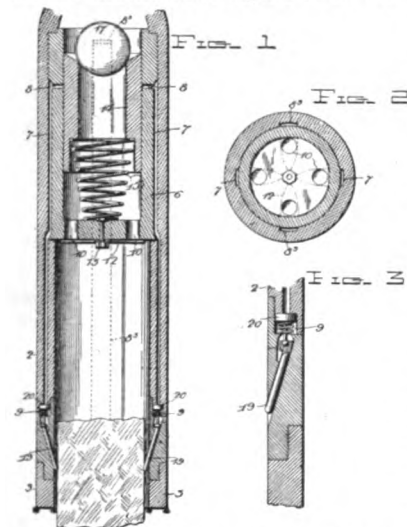
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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CORE LIFTER FOR DIAMOND DRILLS.

No. 650,686. G. LEASK, NANAIMO, CAN. Patented May 29, 1900. This invention relates to a special form of core lifter for diamond drills, which is illustrated in Figs. 1 to 3. The crown or bit is shown at 3, and the core barrel at 2.

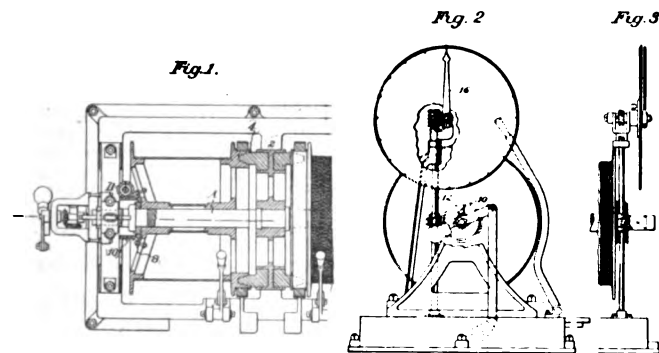


At the upper end of the core barrel a small block 6 is arranged, through the bottom of which are a series of openings 10, which may be closed by a valve 12. Sliding into this piece 6 there is a plug 14, the upper surface of which is intended to receive the ball 17. The piece 14 is supported by the spring 15. The core is secured by means of the pins 19, which work in inclined slots in the core lifter between the bit and the core barrel, as shown in the illustration. Ordinarily these pins are held almost entirely within the metal of the core lifter by means of the springs 9. During ordinary drilling the ball 17 is removed, the water passes down through the center of 14 and 6 and through the openings 10 into the core barrel in the ordinary manner.

When a sufficient amount of drilling has been accomplished so that the core barrel is probably filled, the ball 17 is dropped down through the rods. It closes the opening in 14, after which, by continuing the water pressure, the spring 15 will be compressed until the ports 8 are uncovered, after which water will flow down through the opening 7, depress the piston valves 20, compressing the spring 9, and forcing the pins 19 out against the core, as shown in Fig. 1. As soon as any strain is brought upon the rods to remove them from the hole, the friction of the core tends to draw the pins 19 still farther out and thus lock the core so as to break it off and remove it. When drilling is being carried on in coal or other friable material which would be liable to be washed away by the large amount of water passing through the core barrel, the valve 12 is closed and the water passes into the ports 8² down through the passages 8³ directly to the bit or crown, thus protecting the core in the core barrel from the action of the water.

WINDING-DRUM INDICATOR.

No. 652,546. WILLIAM F. MURRAY, SAN FRANCISCO, CAL. Patented June 26, 1900. This invention relates to winding drums in which the



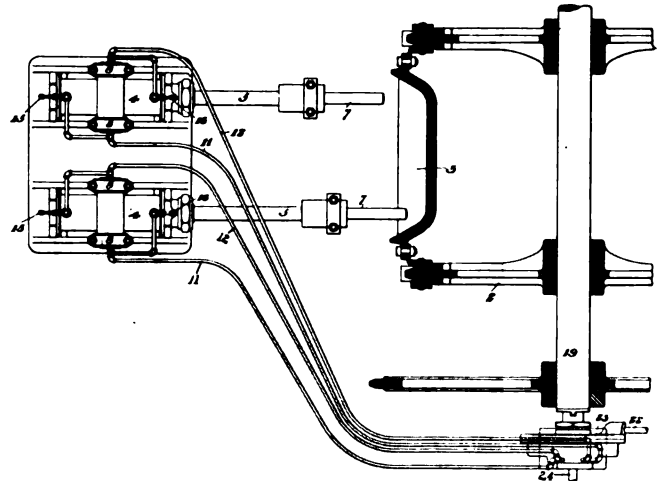
drum turns upon a shaft and to which power is applied from the shaft by means of a friction clutch. It consists of devices connected and operated directly from the drum upon which the rope is coiled in hoisting so that the amount of rope wound upon or unwound from the drum will be accurately indicated independent of any slippage or lack of unity of action between the drum and its driver.

A is a shaft to which the power is transmitted from any suitable

motor, and 2 is a wheel or driver fixed upon the shaft and revoluble with it. This wheel or driver has the frictional rings or equivalent devices projecting from one side near the periphery and adapted to engage with or be disengaged from a corresponding engaging portion 4 of the winding drum. This drum turns loosely upon the shaft A, and by suitable mechanism operating in line with the shaft the frictional surfaces may be forced into contact with such pressure that a sufficient power is communicated to rotate the drum. By relieving the pressure the drum may be allowed to turn independently of the shaft without stopping the motion of the latter, and the cage can thus be lowered. Any suitable brake mechanism may be employed to control the movement. 8 is a plate or disk bolted upon the end of the drum having suitable lugs and bolt holes being centrally perforated to fit over the hub and central portions of the drum. This plate or disk has a cylindrical sleeve projecting outwardly from it and carrying the threads of a worm-gear 10, and this worm engages with the teeth of a corresponding gear-wheel 11, which turns a shaft 12, and by the mechanism shown the pointer 16 is worked in front of the dial plate.

PIG EJECTOR.

No. 650,596. F. L. WHITE AND M. G. SEMPLE, PITTSBURG, PA. Patented May 29, 1900. This patent covers a device for removing pigs from metal moulds which are arranged in a continuous line between sprocket chains, and the general principle is shown in the accompanying figure, in which 3 represents one of the moulds between the sprocket wheels 2. Opposite the center of the sprocket wheels are arranged two cylinders 4, in which work piston rods 5 carrying hammerheads 7. The pistons are operated by any suitable fluid, as air or steam, which is conducted to and from the valves by pipes 11 and 12, from the rotary valve 23 which is placed upon a continuation of the shaft 19 carrying the sprocket wheels about which the moulds pass. 22 is the main fluid supply pipe and 24 the exhaust pipe. Ports are arranged in the valves



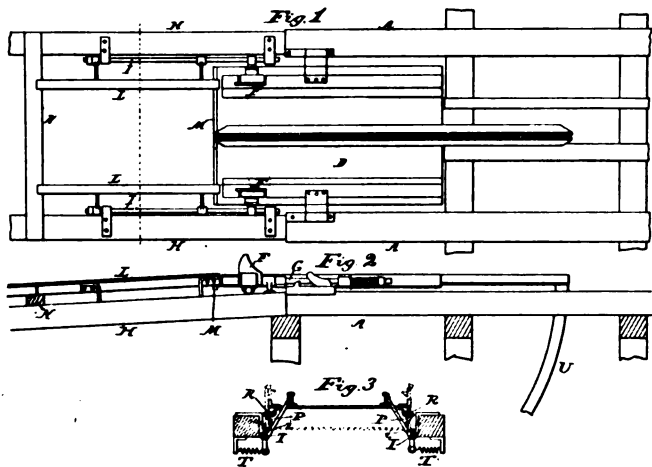
so that the fluid is pumped through first one and then the other of the cylinders 4, so that two sharp blows are struck near the opposite ends of the pig in the mould, one blow being struck just in advance of the other, thus loosening the pig and driving it out of the mould. The cylinders 4 are mounted upon trunnions 8 and maintained in place by springs underneath, which can be adjusted to give the hammers 7 any desired elevation. The object of the springs is to return the hammers to their place when they are dragged out of position by any pig leaving the moulds. In the form shown the pistons are cushioned at the end of the stroke by fluid introduced through the pipes 15 and 16, though the patent also covers the alternate device for cushioning by means of springs.

COAL-DUMPING APPARATUS.

No. 654,019. JOHN M. PHILLIPS AND JOHN J. FLEMING, PITTSBURG, PA. Patented July 17, 1900. In an automatically dumping tipples it has been customary heretofore to provide dropping crossover-rails, which were attached at one end to the swinging or tilting platform, and at the other end were hinged to or rested on the stationary framework of the tipple structure, so that as the swinging platform dropped down the dropping rails went with it, preserving, however, their alignment with the rails on the tilting platform and the stationary rails beyond. The dropping rails being thus always maintained in position below the end of the car, were to some extent in the way of the falling coal, and it would frequently happen that lumps of coal striking the dropping rails would, instead of falling into the chute or screen, fall over the outside of the dropping rails and onto the ground below. This invention dispenses with dropping rails and provides crossover rails of novel form, which upon the dropping of the tilting platform, are automatically swung entirely out of the path of the falling coal, and which automatically resume their position in alignment with the rails of the tilting platform as soon as the latter has resumed its horizontal position. Fig. 1 is a plan view of a tilting tipple. Fig. 2 is a vertical longitudinal section of the same, and Fig. 3 a transverse sectional view on the dotted line Fig. 1. The tilting platform is mounted on the tipple structure. Plates or blocks serve as rocker-bearing surfaces upon which are rockers, which serve as the fulcrum of the tilting platform or tipple. The car-stops FF are secured to rock-shafts G, which rock

and move the horns out of the way of the wheels of the car by mechanism under the control of the tippie operator. Beyond the timber *A*, and in substantial alinement therewith, heavy timbers *H* are arranged, being a part of the tippie structure, and upon the inner sides of the timbers *H* are rocking-shafts *II* journaled in the eyes *ii*. The cross-over rails *LL* in their normal position of alinement with the rails of the tilting platform, rest at one end upon a bar *M*, on the tilting platform, and at their other ends rest upon a cross-beam *N* of the tippie structure. The rails *LL* are rigidly connected with the rock-shafts *II* so that as the rock-shafts turn or rock the rails *LL* will swing outwardly until they are entirely out of the way of the coal which falls from the car.

An inspection of Fig. 3 of the drawings, shows the parts in their normal position in full lines, and in the position which they assume when the platform is tilted, in dotted lines. The rock-shafts *II* extend beyond the inner ends of the crossover rails *LL* and alongside the tilting platform *D*, and are provided with curved bearing-plates *PP*, with which contact rollers *RR*, secured in suitable bearings on the bottom of the tilting platform *D*. The rock-shafts *II* are provided with hangers, Fig. 3, to which are attached springs *TT*, the purpose of



which is to return the rock-shafts and the crossover rails to their normal position, after the tilting platform has assumed its horizontal position.

When a loaded car runs onto the tilting platform it is stopped by the horns, or stops *F*, in such position relatively to the rockers that the weight of the car and its load will overbalance the tilting platform, which is allowed to tilt by releasing a brake that works against a curved depending sector *U* at the rear end of the tilting platform. As the tilting platform tilts, the rollers *RR*, bearing against the curved pieces *PP*, rock the shafts *II* and swing the rails outwardly until they have assumed the position shown in dotted lines in Fig. 3 of the drawings—that is, to each side of and entirely away from the space through which the coal falls from the car to the chute or screen. When the coal has been dumped upon the chute or screen, the tilting platform, being weighted at its rear end, resumes a horizontal position, and as its forward end rises, the crossover rails swing back into their former position in alinement with the rails of the tilting platform, being assisted by the spring *T*. The stops *F*, being now moved out of alinement with the wheels of the car, the latter is run over the crossover rails *LL* and onto the stationary track beyond, from whence it is switched onto a parallel track and taken back to the mine.

TRIPOD AND CLAMP FOR ROCK DRILLS.

No. 653,306. WILLIAM K. MILHOLLAND, CHICAGO, ILL. *Patented July 10, 1900.* This invention relates to the means for joining the several legs and head of a tripod and for adjustable clamping and slide frame for the cylinder of the drill to the head of the tripod.

A B are the front legs of the tripod and *C* its rear leg, the latter being bifurcated at its upper end, having the two arms *cc*, each of which is provided with a journal-box *M*, having a cap *m* secured thereto by means of bolts. The leg *C* is, by means of the boxes *M* and their caps, pivoted upon a sleeve *E*, mounted upon a shaft *D* and in screw-threaded engagement therewith, as shown at *d*.

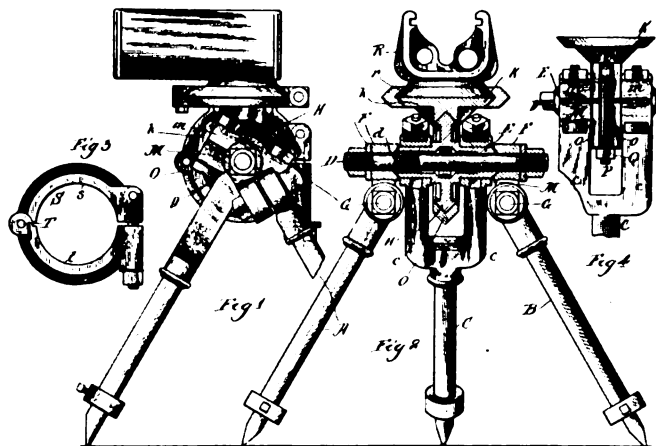
The front legs *A B* are pivoted upon the shaft *D* at the opposite ends of the sleeve *E* by means of hip rings *FF*, and pivot bolts *GG*. The extreme ends of the shaft *D* are threaded, and nuts are fitted thereto, washers being interposed between these nuts and the hip rings *FF*, so that as the nuts are turned up the hip-rings are forced against the ends of the sleeve *E*. The ends of this sleeve are beveled, as shown, and the hip rings *F* are correspondingly recessed, so that a conical bearing is secured and the parts may be very readily locked together by the application of pressure in turning up the nuts. Each of the hip rings *F* is thus secured independent of the other, so that either one of the front legs may be adjusted without the collapse of the tripod, the other two legs being secured. It will also be seen that the adjustment of the rear leg *C* may be accomplished without loosening either of the front legs. By this arrangement the tripod becomes much more easily managed than when, as is usual in such devices, the loosening of one leg results in the loosening of one or both of the others.

A disk *H*, integral with the sleeve *E*, is located between the arms *cc* of the rear leg *C*, and its periphery is V-shaped. The saddle-block *K*, having a semicircular base *k*, internally grooved, rests and slides upon

the disk *H*. A semicircular locking-strap *O* is pivoted to one end of the part *k* and is provided with an internal groove adapted to the periphery of the disk *H*. A draw-bolt *P* is pivoted to suitable lugs projecting from the opposite end of the part *k*, and the clamping-strap *O* is provided at its free end with a pair of lugs, between which the bolt *P* is adapted to enter, so that a nut *Q*, applied to the end of the bolt, may be turned up against the rearward faces of such lugs, so as to securely clamp the parts *k* and *O* about the disk *H*. This clamping device being loosened, it will be seen that the saddle-block *K* may be moved to any desired position, thereby changing the pitch of the drill-cylinder.

The upper portion of the saddle-block *K* is in the form of a flat round table having its edges beveled inwardly and downwardly, and the slide frame *R*, adapted to carry the drill-cylinder (not shown), is provided with a foot-block *r* of like form, its edges being beveled upwardly and inwardly.

A circular clamp *S*, comprising two semi-circular members *s* and *t* joined together, as shown at *T*, and having an internal V-shaped groove, is adapted to encircle the table of the saddle-block *K* and the footpiece *r*. When this clamp-ring is loosened, the frame *R* may be turned to any desired angular position, and by tightening up the ring



it may be securely clamped in such position. The form of the ring and of the parts clamped thereby is such that by a wedge action the contacting faces of the foot *r* and the table of the saddle-block are drawn together, the groove of the clamping-ring also binding tightly against both parts, so as to prevent rotation.

PATENTS ISSUED DURING JULY AND NOT ILLUSTRATED.

- Nos. 652,312, 652,313, 652,314, 652,315. Apparatus for loading or unloading coal and ore, G. H. Hulett, Akron, O.
 No. 652,329. Pulverizing machine, G. Raymond, Chicago, Ill.
 No. 652,346. Ore roasting furnace, A. A. Chainey, Sanford, Me.
 No. 653,679. Machine for crushing ores, etc., S. W. Kimble, New York, N. Y.
 No. 653,771. Stone or ore crusher, A. C. Hilsinger, Killawog, N. Y.
 No. 653,792. Centrifugal ore separator, A. Dasconaguer, Mex.
 No. 653,940. Clutch mechanism for mine cages or lifts, R. Schulz, Herne, Germany.
 No. 653,202. Ore-roasting furnace, P. Argall, Denver, Colo.
 No. 653,205. Placer-mining dredge, S. K. Behrend, Washington, D. C.
 No. 653,285. Actuating mechanism for concentrating tables, D. Cole, Chicago, Ill.
 No. 653,324. Bucket conveyor, G. L. Stuebner, New York, N. Y.
 No. 653,340. Apparatus for separating metallic from rocky constituents of ores, F. E. Elmore, Leeds, Eng.
 Nos. 653,342, 653,344, 653,345, 653,346. Magnetic and Dimagnetic separation, E. Gates, Chevy Chase, Md.
 No. 653,414. Process of extracting copper or other metals from tailings or ores of such metals, E. Fink, Milwaukee, Wis.
 No. 653,444. Apparatus for ventilating mines, H. Fullwood, North Carlton, Victoria.
 No. 653,468. Method of rendering anthracite coal conductive, etc., W. J. Burke, Scranton, Pa.
 No. 654,270. Apparatus for loading or unloading mine cages or buckets, J. F. McKay, Prosperity, Mo.
 No. 654,290. Ore-concentrator, A. H. Stebbins, Little Rock, Ark.
 No. 654,307. Coke-oven, E. Coppee, Brussels, Belgium.
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 No. 654,981. Boring apparatus, J. Howarth and W. Pruszkowski, Schodnica, Austria-Hungary.
 No. 655,123. Dry-kiln, A. H. Simms, Birmingham, Ala.
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 No. 655,162. Coke breaker, P. F. Poorbaugh, Allegheny, Pa.
 No. 654,661. Ore-separator, J. F. Mitchell, Topeka, Kans.
 No. 654,662. Ore-separating machine, J. F. Mitchell, Topeka, Kans.
 No. 654,804. Process of obtaining oxide and carbonate of zinc from materials containing zinc, G. Rigg, Swansea, Eng.

Mines and Minerals

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LIMONITE ORES OF PENNSYLVANIA.

Their Composition and Forms and an Account of the Various Places Where They are Mined in the State.

Written for MINES AND MINERALS, by T. C. Hopkins, Ph. D.

Pennsylvania has always been the greatest iron-manufacturing state in the Union and except during the last decade she has been the greatest iron ore-producing state. But in recent years many of the iron manufacturers have found it more profitable to use ores shipped from Lake Superior than to use those mined in Pennsylvania. Hence a great many of the Pennsylvania ore mines have ceased producing, not because they were exhausted but because they could not compete in quality and price with the lake ores. However, not all the ore mines stopped producing and many that did stop for a time, are again in operation to a greater extent than any one would suspect who has not been over the region.

The history of the iron ore industry in Pennsylvania is an interesting and important one, but the object of the present paper is to discuss certain economic features of the present condition of one of the most important classes of ore, namely the limonite. The hematite and carbonate ores have been important sources of iron in the state; the magnetite ores have been and still are important, but the limonites have been produced in larger quantities than any of the others, possibly because they are more widely distributed and more easily mined.

The limonite ores occur in every county in the state of Pennsylvania, but in only a comparatively few counties are they mined at present. They occur in strata of every geological horizon, but practically all the ores mined at present come from a series of limestones and slates known as the Cambro-Silurian, or, as they are now frequently called, Cambro-Ordovician. The lower portion of the series consists of slates, quartzites, and some limestones carrying fossils which indicate Lower Cambrian age; the upper portion of the series contains Trenton fossils of the Ordovician period. The middle portion of the series is almost barren of fossils and since it is not possible to readily or sharply

separate the groups they are usually referred to as the Cambro-Ordovician strata. The limonite ores which occur in the Silurian, Devonian, and Carboniferous strata have scarcely any commercial importance at present and our discussion refers wholly to the Cambro-Ordovician ores which occur in the limestone valleys of eastern and central Pennsylvania and in the slates and quartzites of the South Mountain area. It should be remembered, however, that the ores occur on and not in these strata. The ores have all accumulated since the folding of the strata in late Carboniferous time and probably very largely since the Appalachian uplift in Cretaceous times. The process is still going on and part of the ores have been formed very recently.

Composition.—The ores are commonly referred to as limonite or brown hematite (the miners frequently shorten it to hematite), but the term must be used in a rather broad or lithologic sense,

meaning the hydrous ferric oxide, rather than as a strictly mineralogic term meaning a definite combination of the iron oxide and water in the ratio of 2 to 3. As may be seen from the following analyses the ores have a complex and variable composition. Besides the iron and water there is always a considerable percentage of silica and alumina, a variable percentage of manganese, and a small per cent. of lime and sulphur. These are commonly called impurities, but some of them are always present and are as truly constituents of the ore as the iron itself. They are found in the purest and most carefully selected specimens, and are not separable from the iron oxide by any mechanical means.

The three common mineral forms of the hydrous ferric oxide

are limonite $2Fe_2O_3 \cdot 3H_2O$; göthite, $Fe_2O_3 \cdot H_2O$; and turgite $2Fe_2O_3 \cdot H_2O$, and the less common form xanthosiderite $Fe_2O_3 \cdot 2H_2O$. It is not always possible to tell whether the commercial ores, commonly called limonite, are admixtures of the above in varying proportions, or whether new compounds are formed with the iron and water in a different but definite proportion. Nor is it possible to determine always the mineral composition of the other constituents. Part of the silica appears to be chemically combined with the iron as the ferric silicate, but whether as anthosiderite $2Fe_2O_3 \cdot 9SiO_2 \cdot 2H_2O$ or chloropal $Fe_2O_3 \cdot 3SiO_2 \cdot 5H_2O$ or some other form has not been determined. The alumina



HUNTER ORE BANK, NITTANY VALLEY, SHOWING OCCURRENCE OF ORE IN EROSION CAVITIES IN LIMESTONE.

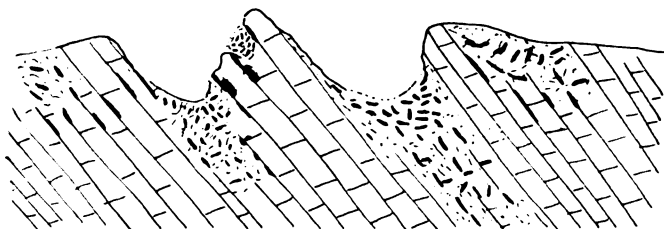
evidently combines with the silica, but whether as kaolin or in some more complex molecule is not known. The phosphorus may combine with either iron or alumina as hydrous phosphate. Since wavellite, an aluminum phosphate, has been found at several ore pits, it is thought that possibly a considerable portion of the phosphorus occurs in this form.

I have selected four chemical analyses and computed the hypothetical mineral composition by putting all the phosphorus into wavellite, the remaining aluminum into kaolin, and the remaining silica into anthosiderite. By computing the phosphorus as dufrenite and the silica as chloropal, it brings out a little different ratio for the remaining iron and water.

A HYPOTHETICAL MINERAL COMBINATION OF THE ELEMENTS IN THE LIMONITE ORES.

	No. 1, Bull Ore Bank.		No. 2, Hostler Ore Bank.		No. 3, Pennsyl- vania Furnace Ore Bank.		No. 4, Lytle Ore Bank.	
	%	Molec- ular Ratio.	%	Molec- ular Ratio.	%	Molec- ular Ratio.	%	Molec- ular Ratio.
Fe_2O_3	81.48	.509	78.58	.491	88.74	.524	82.00	.512
Al_2O_3	.49	.006	.88	.009	.33	.008	1.94	.019
SiO_2 , Combined	8.98	.066	4.25	.071	2.57	.043	2.98	.060
Quartz			2.60		.44		.44	
H_2O	18.90	.772	12.41	.690	12.13	.674	12.10	.672
P_2O_5	.08	.001	.36	.002	.14	.001	.37	.008
MgO	tr		.54		.34		.17	
CaO	tr		.30		tr		tr	
MnO_2			.08		.31			
	Per Cent.		Per Cent.		Per Cent.		Per Cent.	
Limonite	92.800		65.72		54.23		44.506	
Goethite			28.49		39.95		44.704	
Anthosiderite	5.914		4.047		4.06		2.387	
Wavellite	.394		.993		.454		.763	
Kaolin	.774		1.290		.258		3.612	
Quartz			2.600		.440		.440	
$Fe_2O_3 : H_2O$	496 : 747		478 : 652		515 : 660		506 : 625	
	2 : 3 nearly		3 : 4 nearly		4 : 5 nearly		4 : 5 nearly	

Form of the Ore.—The ore occurs in a great many different forms which might for convenience be divided into the following classes: 1. *Nodular ore*, which includes the so-called bomb-shell or pot ores and occurs in nodular rounded masses varying in weight from a few ounces to several hundred pounds. These masses sometimes include fragments of chert or sandstone or slate, sometimes a mass of soft clay and in some instances they are filled with water and sometimes are entirely empty. These ore shells are sometimes formed by the deposition of the iron oxide on rock fragments which is shown by the occurrence of these in the various stages of formation from the rock fragment with a thin coating of iron oxide to those in which the iron coating becomes thicker and thicker. As the iron shell increases in thickness, the inclosed rock softens and disintegrates until there finally results an iron shell inclosing loose clay or sand or it may be entirely empty. Some of these ore shells are nodular segregations in slate or limestone when the iron oxide replaces the original rock. Some of these have been found in the slate beds and still retain the lamination of the slate and enclose laminated clay. There has been a deposition of iron oxide



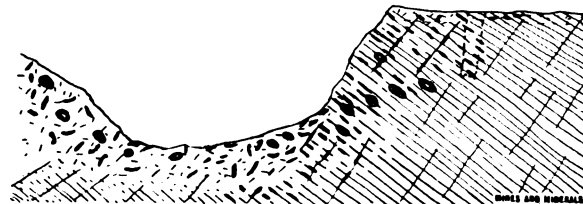
SECTION OF ORE BANK AT PENNSYLVANIA FURNACE, PA.
Illustrating Mode of Occurrence of the Ore in Limestone.

in the interior of some of these shells since they were first formed, as shown by the fibrous layers and the mamillary interior surface and conclusively by numerous small iron oxide stalactites found in some of them.

(2) There are two types of *pipe ore*, one consisting of large pipes in which the ore has apparently been deposited around some foreign body, probably calcite stalactites which have subse-

quently leached out. The other form of pipe ore consists of smaller, nearly solid pipes that have evidently been formed in a cavity. It is more common and abundant and likewise a purer ore than the first type.

(3) The *brecciated ore*, one of the most common forms, consists of irregular more or less cellular fragmental masses formed commonly by the deposition of the iron oxide as a cement in a loose mass of fragmental chert, limestone, sandstone, or other



SECTION OF ORE BANK AT HENSINGVILLE, PA.
Illustrating Mode of Occurrence of the Ore in Slates and Clay.

material. There is probably more or less replacement of the rock material by the iron, as in the case of the first class which it resembles in many ways. Frequently the inclosed rock fragments have disintegrated and have been leached or filtered out, leaving the cellular ore. Sometimes the rock fragments remain in which case the ore is so highly siliceous as in many cases to have little commercial value.

(4) *Sheet or flake ore* is a form that occurs in the joints or seams of the slates or limestones, generally in comparatively thin irregular flakes. It has commercial value only when the inclosing rock has completely disintegrated so that the ore can be easily separated from the other residual material.

(5) *Fragmental ore* is the form in which most of the preceding are commonly found and the fragments are frequently so small that the original form of the ore can no longer be determined.

(6) *Yellow ochre*, while not strictly an ore of iron is the most common form of occurrence of the iron oxide. It consists of the finely divided iron oxide disseminated through the clays, and occurs associated with the ores where they are present and in many places where the ores are absent. It is used to some extent for mineral paint.

Mode of Occurrence of the Ore.—The ore occurs intermixed with clay, sand, chert, and other residual materials (1) in eroded cavities or pockets in the upper part of the limestone, (2) resting upon or against masses of residual white clay, (3) lying upon beds of sandstone, or sand resulting from the same, (4) occasionally in the bedding and joint seams of the limestones or slates.

The areal extent of the single ore deposits varies from a few square yards to many acres. The Scotia mines in Nittany Valley have been worked over an area of more than 100 acres and the limits have not been reached. The deposits vary in depth from a few feet to several hundred. Many of the ore pits are not worked beyond a depth of 80 or 90 feet owing to the expense of lifting the material from a greater depth and of keeping out the water. The actual depth of ore in a few places is surprisingly great. Thus at the Lehman mine in Cumberland county, the record of a boring gave 340 feet of ore, underlain by 40 feet of blue clay, 30 feet of white clay and 20 feet of "Mountain clay," 435 feet in all. At Lambourne in the Nittany Valley, a boring 766 feet shows 300 feet of ore and clay, 450 feet of sand and 16 feet of limestone. Theoretically the maximum depth of the ore deposit is the level of the master stream draining the area. Not many extend to this depth and a few apparently extend below it.

Lesley and Prime, 2nd Penna. Geol. Surv., Final Report and Reports D and DD., both emphasize the statement that the ore occurs in regular belts along definite horizons. Rogers' Geol. Surv. of Pa., 1858, Vol. I, says the occurrence of the ores is empirical and bears no very close relation to the underlying rock except in the Kishacoquillas Valley where he finds that the ores occur over the anticlinal axes in the fissures produced by the flexures of the limestone.

The conclusion of the writer is that ore deposits may occur at any horizon on the limestones, as may be seen by field examination or by consulting the maps of the ore pits in Lehigh, Berks, and Center counties, but since the location of many of the ore deposits is determined by the beds of hydromica slates or the white clays resulting from their decay and since these are generally of considerable extent, there is, where these intercalary slates or clays occur, a tendency to alignment of the ore deposits following the clay belts. This is well illustrated in the map of the South Mountain ore pits in Cumberland county (see Annual Report 1886 Pt. IV 2nd Pa. Geol. Surv.). A bed of sandstone intercalated in the limestone may bring about the same result (see map of Center Co. Report, T, 2nd Pa. Geol. Surv.). In limestone areas where the slates and sandstones are absent there is no

definite alignment about the ore deposits (see Lehigh county map of the ore pits).

Origin of the Limonite Ores.—The source of all the iron and the mode of its accumulation into the ore pockets are interesting and difficult problems which confront the inquiring geologist. Iron is one of the most widely distributed elements in nature; in fact it is so universally distributed that no rock mass is entirely free from it, but it is more abundant in some than in others. All of the strata associated with the ore deposits contain iron, as shown by chemical analyses, ranging from a fraction of one per cent. to six or eight per cent. The ores are produced by the segregation of this diffused iron into the commercial deposits.



SAMPLES OF LIMONITE ORE.

Pipe and Brecciated Ore, one Piece near the Center Shows Sandstone Fragment Incrusted with Ore.

It does not follow, however, that the strata are all of equal importance in the quantity of iron supplied to the ore deposits. The greater part of the iron is thought by the writer to come from the Cambro-Ordovician limestones, and their included slates because (1) most of the ore deposits occur on the limestone areas or on the slates immediately below the limestone; (2)

the limestones contain iron in sufficient quantities to supply the ores; (3) the mode of disintegration of the limestone, which is almost wholly by solution, is most favorable to the accumulation of the iron into the form of ore and its preservation. Shales and sandstones weather away almost wholly by mechanical erosion and most of the iron contained in them would be carried away with the sediments. One might question at first thought the adequacy of the supply when we consider that the analyses of the limestone show only from one to five per cent. of iron. But if we consider that one per cent. of iron means a thickness of 40 feet of iron ore in 6,000 feet of limestone, the supply does not seem so small. However, we should compare the iron with the other insoluble material of the limestones, in which case we find that the iron averages about 24% which is up to the average of that in most of the ore pits. Any mathematical calculation on this line must be indefinite because in the first place we cannot tell how much iron is carried away by the streams, nor what per cent. of it is diffused through the clay as ochre; on the other hand there is (1) considerable lateral segregation of the iron as shown by the barren areas between the ore deposits, and (2) in the highly folded strata (nearly all the strata are sharply folded) the thickness of limestone eroded over any ore deposit may be much greater than the normal thickness of the limestone at that place.

Some of the iron of the ores is derived from the shales and slates overlying the limestones but only a comparatively small part. Some is derived from the underlying Cambrian slates but the bulk of it comes from the limestones. The ores are formed by the segregation of the iron into solid bodies partly (1) by replacement of the original rock material, (2) in cavities in the limestone, (3) in the joint and bedding seams of the limestones and slates, and (4) by deposition on the rock fragments at the surface or in cavities or on the beds of clay or sand. Sometimes the inclosed rock fragments are retained in the ore, making them very impure and sometimes they have disintegrated and crumbled out. All stages of the process may be observed in some of the mines, from the compact rock fragments and those partially disintegrated, to the iron shells inclosing loose clay or sand and those entirely empty or filled with water. Where the iron is deposited on an accumulation of rock fragments, it may form a considerable ore mass having a brecciated or conglomerate texture, and being very silicious if the rock fragment remain, or quite porous if the inclosed rock fragments have been leached out.

In the northward extension of the Great Valley in New York, the ore has been shown in some localities to result from the disintegration in situ of a highly ferruginous limestone. In the southward extension of the Great Valley in Tennessee some of the deposits are said to be the oxidized portions of pyrite veins. No positive evidence could be found that any of the deposits in Pennsylvania originated in this way.

Development of the ores.—The ores have been mined quite extensively in all the Cambro-Ordovician limestone and slate areas in Pennsylvania, in fact all along the Appalachian range. The

ore pits are scattered indiscriminately over the limestone portion of the Great Valley and the smaller parallel limestone valleys and portions of the slate and quartzite areas. Some of the most productive localities are Iron-ton in Lehigh county, Kline's Corners in Berks county, Boiling Springs and Mountain Creek in Cumberland county, Mt. Alto in Franklin county, Bellefonte, Scotia, and Pennsylvania Furnace in Center county, and Ore Hill in Blair county. The following list of the limonite ore pits has been compiled largely from the maps and reports of the Second Pennsylvania Geological Survey. It includes the idle as well as the operated pits so far as could be ascertained. Some of the pits are small and have produced possibly only a few tons of ore, while some have produced at the rate of several car-loads of ore per day.

Productive and abandoned limonite ore pits of the Cambro-Ordovician areas in Pennsylvania:

County.	
Lehigh	202
Berks	25
Lancaster	27
Dauphin	5
Cumberland	101
Franklin	49
York	157
Center	79
Huntingdon	80
Blair	32
Total	707

Besides the ore pits enumerated, there are a great many in Northampton, Lebanon, Chester, Mifflin and Bedford counties of which no definite figures could be obtained. The list does not include any ore pits that have been opened since the Geological Survey reports were published which was 20 years or more ago for some of the counties. So that probably the total number of openings from which the Cambro-Ordovician ores have been mined in the state is not far from 900.

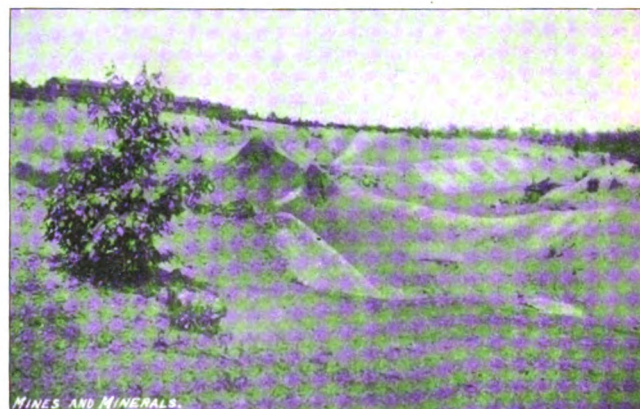
The production of the ores at present while more than it was a few years ago, is quite limited compared with that in the decade between 1860 and 1870.

In Center county several mines near Bellefonte are in active operation supplying ore for the Bellefonte furnaces. The Scotia mines, the largest in the county, have been in almost continuous operation for many years. Until recently they were controlled by the Carnegie Company but since the spring of 1899 the ore is shipped to the Bellefonte furnaces. The Hunter and Lambourne banks near Scotia are active producers.

The Ore Hill mines in Blair county have been shipping ore for many years. At the present time 100 men are at work mining and shipping ore and clay.

The large ore pits in Franklin and Cumberland counties have been idle for many years except the two large banks of the Reading Iron Co., south of Boiling Springs which began operations shortly before the outbreak of the Spanish-American war, which cut off the supply of Cuban ore from the eastern furnaces. During 1897 they shipped about 3 car-loads a day, in 1898 about one carload per day.

There is considerable activity among the ore producers in eastern Berks county. In the immediate vicinity of Kline's



SCOTIA ORE BANK, SHOWING FACE. STEAM SHOVEL USED IN LOADING, AND BARREN AREA.

Corners (Schweyer post-office) there are 8 ore washers and banks in operation, and small quantities of ore are shipped from ore mines near Albert's Station. One of the 3 large ore mines south of Fogelsville is washing and shipping ore.

Siegers mine at Siegersville was reopened in 1899 and is mining the ore in drifts run in from the sides of the old pit opening. The large Iron-ton mine after lying idle for 13 years

was reopened in the spring of 1899 and shipped ore during the summer at the rate of 3 or 4 carloads per week. At Guth's Station between Ironton and Allentown are two limonite mines in operation, both of which are now worked through vertical shafts, the ore being lifted by steam hoists. The depth of the shaft is 125 feet. About a mile east of Guth's Station is another limonite mine in operation, worked in an open pit 75 to 80 feet deep.

Lerch's ore pit near Bath in Northampton county is producing considerable limonite ore.

The ore mines above enumerated are those I observed in operation in 1899, but it is quite probable that there were some others operated that are not mentioned as my field work did not take me into all parts of the area.

Methods of Mining the Limonite Ores.—In some of the smaller pits the ore has been obtained by digging over the material with pick and shovel and picking out the lumps of ore by hand. At nearly all the larger pits washers have been erected in which the clay and sand are separated from the ore by the use of water. The washers used are the common log washer consisting of a horizontal beam set with short metallic arms and rotating in an open trough into which the material is dumped along with a constant stream of water. The arms are so placed on the shaft as to slowly move the ore and rock fragments forward to an opening in the trough where they drop out, while the stream of water

In a few localities the ore appears to be concentrated along certain horizons under a more or less barren overburden of considerable thickness, so that it is found to be cheaper to mine the ore in underground workings, from which it is elevated to the surface through a vertical shaft, as at Guth's Station, or by an inclined slope, as by the Reading Iron Co., near Roaring Spring.

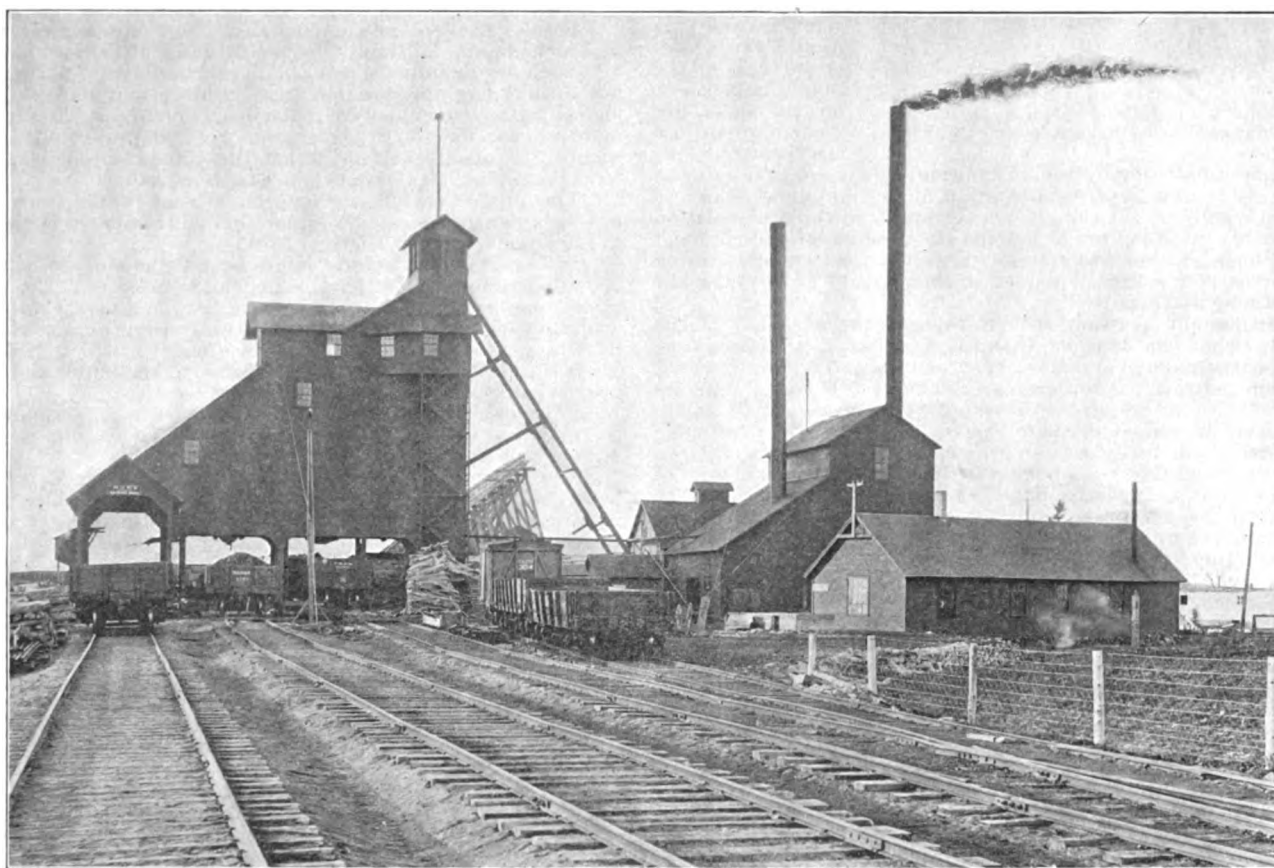
It is probable that the limonite ores of Pennsylvania will never reach the importance they once had in the market, as they cannot compete with the larger deposits of richer ore in other localities. Yet at the present price of iron, they can be mined profitably for local use in even larger quantities than at present, and the indications are that more mines will be opened in 1900 than there were in 1899.

PERE MARQUETTE MINES.

A Description of One of the Largest and Best Equipped Coal Mines in the State of Michigan.

Written for MINES AND MINERALS, by R. A. Randall.

The Saginaw, Pere Marquette and Verne Coal Companies, located at Saginaw, Mich., are now hoisting twelve hundred tons of coal per day from their four shafts. The Pere Marquette No. 2 is



SURFACE WORKS AT PERE MARQUETTE MINES.

carries away the clay and sand. Formerly jigs were used at some of the larger mines for separating the heavier ore fragments from the lighter rock fragments. At some of the mines this separation was made by hand-picking. At present neither process is used and the rock fragments are shipped with the ore and fluxed off in the furnace. The washers are erected at an elevation of 20 or 30 feet above the surface so that the ore can be dumped from the washer directly into the railway car without rehandling.

In most places the ores are mined in open pits and drawn by cable up an inclined tramway to the washer. In the large pits branch roadways are extended out to different portions of the pit. In the Scotia mine the area worked over is so large that a locomotive is used to move the cars to the foot of the incline at the washer. Commonly the material is mined and loaded on the ore cars by hand but in the Scotia mines this is done by steam shovels of which there are three in operation.*

*See article "Iron Ore Mining," The Colliery Engineer and Metal Miner, Vol. 16, page 101, for details of steam shovel mining at Scotia.

the best equipped shaft in the State of Michigan. Ground was broken for this shaft March 6th, 1899. The dimensions are as follows: Six feet eight inches by sixteen feet in the clear, measuring two hundred and five feet to the coal. It is divided into three compartments; two for hoisting, of five feet one inch, the third being used for an airway and the pump pipes. The sinking was done under the supervision of Mr. John Weaver, the present superintendent of the mine. Three shifts were employed of eight hours each, with seven men to each shift, four in the shaft and three on top. 10" x 10" white oak timber was used, and each set fitted and joined together to resist lateral pressure. The sets are placed twenty inches apart with 6" x 12" bunting timber making the divisions. Between the sets 2" oak plank was used for lagging.

The bottom was opened sixteen feet wide by one hundred and twenty feet in length on each side of the shaft. The coal is worked room and pillar on the double entry system. A pillar of twenty feet is left between the entries. The butt entries are

driven about three hundred feet apart and from them rooms are turned thirty-five feet apart. The rooms are worked twenty feet wide with ten to fifteen feet of pillar between, and are driven about one hundred and fifty feet in length. The coal averages about three feet three inches thick.

The mine is ventilated by an S. B. Stine ten-foot fan, the air being split at the bottom of the shaft, one half being used on each side. An air-shaft is being sunk three hundred feet from the main shaft, which will eventually be used for ventilation as well as an escape shaft.

The mine is drained by ditches, where practicable. The water runs into sumps, and where ditches cannot be used, No. 5 and No. 10 Knowles pumps are installed and the water forced into the main pump at the bottom of the shaft.

Haulage is by mule power. Steel cars are used, five feet six inches long by two feet wide, spreading to three feet and holding on an average one thousand pounds of lump coal. At present the mine is hoisting from six hundred to six hundred and fifty tons of "run of mine" per day, of eight hours.

The top works consists of a tippie sixty feet high to the wheel house, which is eight feet in height and made of slat work to provide for the escape of the air during the winter, when it is forced through the hoisting shaft. From one side of the tippie a building forty-three feet high extends over two railroad tracks; attached to this is the scale house, fourteen feet wide, sixty feet long, and with eighteen foot posts. This covers a fifty-two foot eighty ton Howe railroad track scale. Inside of the main frame, there is a second, constructed similar to the first, of 10" x 10" pine. This inside frame carries a screen, with which this tippie is equipped.

The hoisting is done by a pair of 16" x 24" direct-acting engines, fitted with a double conical drum; the cones, running from four feet at each end to five feet in the center. They are capable of making the hoist of 250 feet in ten seconds, including the dumping of the automatic cages. The coal on leaving the pit cars, passes over a seven-eighths diamond bar screen; the lump is weighed on automatic scales and is passed over a patent shaking screen, where it is separated into three grades, domestic lump, steam lump and slack. The slack passes through seven-eighths by inch and a quarter perforations; the steam lump through four inch holes, and such coal as passes over these holes goes into the domestic lump. Slate and refuse of the mine is hoisted on the cages and dumped into a rock car, which holds ten tons, and is then drawn up a 15° incline by a pair of 7" x 10" geared engines with a thirty-inch drum; here the car opens automatically.

Steam for the entire plant is furnished by one of Wickes Brothers' 200 H. P. vertical water tube boilers.

Two wash houses twelve feet by eighty feet each, have been built for the use of the men, where they change on coming out of the mine. All buildings are heated by steam.

Tunnel Developments at Coeur d'Alene.

Written for MINES AND MINERALS, by W. C. Clark.

The law providing for tunnel site locations has never been taken advantage of to any considerable extent in the Coeur d'Alene, owing to the fact that the ledges generally crop out of the surface at short intervals, and there is little inducement to look for blind leads. Some long crosscut tunnels have been run without finding anything of value not shown on the surface. Thus the Bunker Hill and Sullivan Mining and Concentrating Company is working on a crosscut tunnel at Kellogg which will be two miles long when completed, and nearly a mile and a half has already been run, some of it being nearly 1,000 feet below the surface, where it passes under the Sugar-loaf, southeast from the concentrator, but no ledge has been discovered in it. The Campbell tunnel on the Standard crosscuts for 2,620 feet, but no unknown vein was cut. The Mammoth is running one 3,000 feet long, but it is parallel to the Standard's and so nothing could be expected in it, and the new two-mile tunnel of the Morning mine is as yet in but a few hundred feet. On Sunset Peak Senator W. A. Clark has a 2,600 foot crosscut almost completed, and the only discovery in it was an ore-bearing stringer a few inches wide.

Still there are two remarkable cases of blind leads being discovered here. The first was in the Tiger almost a year ago. The Tiger was the first claim located on Cañon Creek, and was among the earliest to be developed. Except for a little work in early days on the side hill where tunnels could be driven into the ore, it has been worked through a shaft. As the shaft went down the town of Burke grew up around it and all the available ground was located. Still there was no sign of a vein between the Tiger and the Hecla 1,200 feet to the south. In spite of that, when the property was sold to the Buffalo Hump Mining Company a year ago one of the first things to be done by the new company was to put in a diamond drill and explore their ground out of the side lines on either side of the old ore shoot. The shaft was then down 1,600 feet, and in order to catch any blind veins, work was

begun on the 1,300-foot level. To the north in several places the drill was run out as far as the side lines but nothing was found. It was then started south and had only gone 150 feet when a new vein was discovered which the drill showed to be about as wide as the one which had been worked so long, and carrying an ore shoot six feet thick. It was then hunted for on other levels in order to learn how near the surface it came, and the surprising discovery was made that it was as strong 100 feet beneath the surface as where it was first discovered. A crosscut was then run from the 1,300-foot level, and at the time the writer visited the property the ledge had been cut and drifted on either way for 200 feet from the point of intersection, the whole 400 feet showing about the same conditions as where it was first encountered, except that in drifting east there was a gradual widening of the ore body until in the face of the east drift at that time there was 16 feet of ore. The town of Burke was built on the top of this vein, which bore so much ore but 100 feet below, and yet no suspicion had ever been aroused that such a thing existed. The ore now being shipped from the mine largely comes from that vein.

The other case was in the Manhattan, discovered last spring. The claim was an old one on which a shaft had been sunk more than 10 years ago. That shaft was on a narrow vein carrying considerable ore in places, but below the 25 foot level the amount of ore steadily decreased, which led to its abandonment, nothing having been done on it for years except enough to hold the claim. Last fall when Barry N. Hillard took a bond on the Amazon he also secured the Manhattan, the two claims lying side by side, their discovery points being not over 150 feet apart. The ledges ran parallel—as is the case with practically all the veins in the Coeur d'Alene—and when the tunnel was well in on the Amazon a crosscut was started to get under the old Manhattan shaft, to raise to connect with it and thus secure air for the work in the Amazon. Just before making that connection the workmen were surprised by running into an immense body of shipping ore which further exploration has shown pretty conclusively to be a blind vein. The stringer on which the Amazon shaft, or rather incline, was sunk was about 18 inches to 2 feet wide, dipping to the north about 20 feet in the hundred, while the ore body below was 10 to 12 feet thick, dipping at about the same angle to the south. The two came so nearly together that had one more shot been put in the bottom of the shaft the new ore body would have been broken into. No trace of the big shoot has ever been found on the surface.

To the eastward of Mullan, however, there is a region which is untouched, and which will probably never be known unless the tunnel site locator gets in there, as it is covered with bare slide rock to such a depth that there is no chance of getting to the surface of the earth except by tunneling. The region is one which promises much to those who have the courage to develop it, the great mineral belt running through from Cañon creek to the Morning and other mines at Mullan runs into it from the west, while just to the east of it again there is a vast district which shows well on the surface but has been developed but slightly. This region referred to is probably two miles north and south by three or four east and west, and is spread out like a map before the eye of the passenger on the Northern Pacific line between here and Missoula, lying on the north side of the South Fork of the Coeur d'Alene River, while the railroad is winding back and forth climbing the south wall of the same cañon.

A Rat Shutting Down a Central Station.

Rats have been responsible for innumerable troubles with electrical apparatus, from the days of the early electric bells up to the present time, but they do not often do as much mischief as in the instance given below. At a large town in the Midlands, England, whose electrical supply station was worked on a special system of low tension, involving an arrangement in which certain cables entering the station near together had rather a high pressure between them, a certain rat who was exploring the neighborhood underground, ate a piece of the insulation off one of the cables, and then appears to have laid upon his stomach on the bare conductor, where he had eaten the insulation away, while he proceeded to attack the other cable. On biting the second cable while in this position, the rat received a shock which killed him, and he lay there bridging the two cables. As, though his body was of high resistance compared with the conductor, a certain current did pass through his body, which was enough to burn him up, to cremate him in fact, his resistance to the passage of the current gradually became smaller as the cremation proceeded, till at a certain point his body having become practically pure carbon, the short length and comparatively large section offered a very good path for the current, with the result that the fuses, which fortunately were protecting the station, "blew," and the station had to shut down while the cause was being found, which was not altogether an easy matter.—*Colliery Guardian*.

COPPER MINING IN NORTHERN WISCONSIN.

An Account of the Geology, Discoveries, and Development in the Western Lake Superior Copper Region.

Kirby Thomas.*

The subject assigned to me by your program committee, "Copper Mining in Northern Wisconsin," is necessarily somewhat local in its scope and nature. Therefore, I shall make this paper brief and touch only on such general facts as the presentation of my subject requires.

Under the stimulus of high price and the prospect of an increasing demand for copper, the efforts to discover new workable copper deposits during the past two years have almost been equal in interest and geographical extent to the ever continuing search after gold. Every favorable formation has been prospected for the red metal, and as a result, the production of copper hereafter will not be confined to a very few localities. One of the new copper districts which promises to come to the front very soon is the Western Lake Superior district, as the considerable area of Keweenaw or copper bearing rocks in Northern Wisconsin is designated.

Geological Formation.—The Keweenaw formation, in which occurs the copper prospects in Northern Wisconsin, consists of a series of eruptive beds alternating with sandstones and conglomerates, and in its upper division almost wholly composed of detrital deposits interbedded with occasional lava flows. The formation lies above the Huronian rocks and below the Potsdam sandstone of the Cambrian period. The Keweenaw formation in the Lake Superior district was probably laid down in substantially horizontal position at the bottom of the ancient sea. Subsequent earth movements tilted the beds so that they form a great trough or synclinal conforming in a general way to the present bed of Lake Superior. One edge of the synclinal forms Keweenaw Point, Mich., and extends westward across Northern Michigan and Northern Wisconsin, flattening out as it passes into Minnesota. The great Michigan copper mines occur on this edge on Keweenaw Point, at the western end of Lake Superior, both edges of the synclinal being represented by the upper St. Croix valley which was formerly and until recently the outlet of the lake. The northern edge of the synclinal forms the Douglas Copper Range in Northwestern Wisconsin, the hills back of Duluth, Minn., and is exposed along the northwest shore of Lake Superior and on Isle Royale. The lower beds of the Keweenaw formation consist mainly of coarsely crystalline gabbros, from twenty to fifty feet thick. After four or five thousand feet of these flows had spread out in horizontal sheets over this Lake Superior region, the magmas became somewhat different in chemical character, the eruptions more frequent and thinner. These constitute the middle series of the Keweenaw formation and most of the copper mines are located in this division. The upper series consist of alternating eruptives and sandstone or conglomerates.

The absolute identity of the formation in the western Lake Superior district with that in the Keweenaw Point region is proven by the following very eminent authorities. On page 139, Monograph V, of the United States Geological Survey, Mr. Irving, referring to the identity of the eruptive rocks of the St. Croix (Wisconsin) district and the Keweenaw Point formation, says: "This identification is also indisputable; it is so because of the absolute identity in nature and structure of the rocks of the region, and because the Keweenaw belts have been followed continuously from the eastern end of Keweenaw Point, Michigan, to the St. Croix river, Wisconsin. The predominant fine-grained basic rocks of the two regions are so completely the same in mineral composition, even to the alteration-products that thin sections of rocks from the two districts placed side by side are not distinguishable from one another. The rocks of the two regions present precisely the same amygdaloidal, pseudo-amygdaloidal, and compact phases. The amygdulæ are made of the same minerals in both, associated in the same ways. Native copper occurs in the St. Croix valley in the same manner, and with the same associates as on Keweenaw Point. The evidence for all the distance between Keweenaw Point and the St. Croix is just as strong as that ever appealed to prove the continuity of geological formations anywhere. From Keweenaw Point to the St. Croix, the formation has been traced mile by mile." E. T. Sweet, of the Wisconsin Geological survey says, in Volume III of the report of that survey, page 331: "Undoubted Keweenaw rocks are found in Douglas county. * * * They extend entirely across the country, outcropping in a more or less broken line, and forming the well known Douglas Copper Range." Professor T. C. Chamberlin, now holding the chair of geology in the Chicago University,

says (Vol. III, Wisconsin Geological Reports, page 357): "The St. Croix valley and Douglas Range formation is not only the equivalent, as the name implies, of the great copper-bearing terrane of Keweenaw Point, but it is directly continuous with it and forms its southwestern prolongation. It is difficult to assign any satisfactory reasons why an igneous overflow should be richer in a metal at a given point than at any other, and still more difficult to understand how a succession of such overflows, separated by considerable periods of time, should be exceptionally rich in the same region. Theoretically, therefore, there is little or no reason for believing that the igneous rocks of one district are less rich in copper than in other portions."

Development.—The significance of the establishing of the identity of the rocks of the western Lake Superior district with the Keweenaw Point formation gradually filtered down to the laity. The increasing reports of "copper finds" on the Douglas Range led to considerable prospecting, which commenced in earnest about three years ago. The showings were good. Then followed the usual boom and bubble. After some excitement and sorrow, the men who have holdings on the Douglas Range, in the St. Croix district and on the Minong Range, as the exposure of the southern edge of the Keweenaw synclinal in Western Wisconsin is designated, settled down to the serious and hard task of opening up copper mines.

Facilities for Mining.—The whole district is within a few hours' ride of Superior, a considerable city with unexampled railroad and harbor facilities. Roads and railroads make the country easily accessible and solve in advance the important transportation problem. Wood and water and water power are abundant throughout the district. The exposures of the formation throughout Douglas county, Wisconsin, are frequent and prospecting is not difficult. However, a large part of the formation farther east is heavily drift covered. The copper occurs in the amygdaloidal, or porous portion of the beds which dip usually at a high angle. Consequently surface work and trenching is quite satisfactory in showing up a prospect.

Land Titles.—The lands in the more favored localities in this district have been syndicated by local promoters, but well located lands can today be secured for from \$5 to \$10 an acre. The title of the lands in the district is all in individuals and the United States mining laws do not apply.

Local Details.—On the Douglas Range four principal companies are developing today. The Chippewa Copper Mining Company, formerly the North Wisconsin, has a shaft on an ore chute down 200 feet and has done nearly 300 feet of drifting and cross-cutting. This company is controlled in Boston and is satisfactorily financed. The Percival mine has reached a depth of 190 feet and shows a good ore body. The Fond du Lac mine has so far confined its work to surface proving and with very satisfactory results. The company is endeavoring to secure money to sink deep shafts and prove the property. The Culligan Company which was one of the earliest discoveries on the range, has recently been reorganized and is now actively prosecuting development. The Copper Creek mine is also a very good property. A crew has been at work on this location all winter.

The St. Croix district, which is a practical continuation of the Douglas Range, has yielded very rich showings to the prospectors. The land in this range has been bought by the St. Croix Consolidated Mines Company, but as yet no development work has been done. On the Minong Range the only development work undertaken is in Town 43, Range 10, in the southeastern part of Douglas county. Here Mr. Fredrick Weyerhauser, the wealthy lumberman, and some associates have opened up a very rich strike. The preliminary work of proving the property has been done and steps are now underway to install the machinery for actual mining. On both ranges there are many individual prospects of good promise.

Assays.—The Wisconsin Geological Survey made a preliminary inspection of the district last summer (1899). The assays made for the Survey from average samples was as high as four per cent. in native copper. An average sample from the Culligan assayed 4.19 per cent. Average samples from the Fond du Lac gave .39, 1.99, 1.25, 1.37 and 1.21 per cent. respectively. Copper Creek samples gave from .29 per cent. to 1.60 per cent. The Weyerhauser, which was not examined by the Survey, yields nugget copper weighing several pounds. In this connection it should be considered that the Michigan mines give seemingly low percentages, yet are profitable because of the conditions and extent of the ore deposits. The Atlantic mine on Keweenaw Point is paying dividends on an average yield of less than .6 of one per cent rock.

The western Lake Superior district will soon be adding to the world's copper supply. The geological conditions and the prospects actually discovered and proved give reason to believe that the district will yet and soon develop several copper mines, and it may rank along with the Michigan district, world famed for the richness of its copper mines.

*A paper read before the International Mining Congress, Milwaukee Wis., June 22, 1900.

MINING PRACTICE

In Butte, Montana, Copper Mines. Methods Employed in the Various Operations.

Shaft Sinking, Costs, Methods of Timbering, Blasting, Etc.; Drifting, Stopping, and Raising; Hand Drilling, Machine Drilling, Trimming, Haulage, Ventilation, Stopping, Etc.

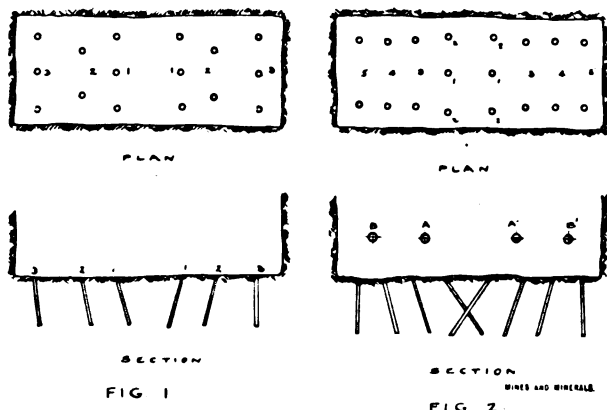
Written for MINES AND MINERALS, by R. B. Brinsmade, B. S., E. M.

In examining the accepted practice of a western mining district that has been worked for a decade or more, it will generally be found that every means is employed to gain an end, and various apparently insignificant little devices (which, however make for smooth and continuous running) are the result of the survival of the fittest of many attempts to apply other methods and devices to overcome the obstacles inherent in the natural and artificial conditions of the district. Of course, improvements are constantly being made in any progressive camp, but in one whose practice is the product of years of evolution, they come only gradually, and are more often the introduction of some new mechanical invention or the equipment with larger and more efficient machinery, as the production and the depth increase, than a change in the method of handling the ground itself.

Hence, a managing engineer entering for the first time a camp whose practice is well established does well to move slowly, and to thoroughly acquaint himself with all the existing obstacles, and with the manner in which they have already been overcome, before attempting to introduce innovations. An old district like Butte is an entirely different problem for the engineer from a virgin camp like Buffalo Hump, in Idaho, or Republic, in Washington, where the methods applied must be for conditions largely novel. The engineer in a newly opened camp, therefore, must first study the actual conditions as far as his time permits, and the methods then applied must of necessity (whatever his previous experience) be largely tentative, and be introduced with the expectation of modification, or perhaps entire replacement by other ones, as the true nature and requirements of the district develop.

The geology of the Butte district has already been touched upon in MINES AND MINERALS by Prof. Arthur Lakes, and an excellent monograph on the subject is the "Butte Special Folio," published by the U. S. Geological Survey, but I shall say a few words on the subject here.

The nature of the country rock is always a vital point to the miner. The Butte granite is unstable when exposed to weathering either above or below the surface, and decomposes from two causes, disintegration and decomposition. Disintegration causes a loosening of the cohesion between the constituent grains, and this has affected all the surface to a depth of 20 feet or more. Decomposition is due to surface and vein waters and to oxidation and it changes the granite finally into a soft clay-like material; its effects extend through all the fissure systems with which the

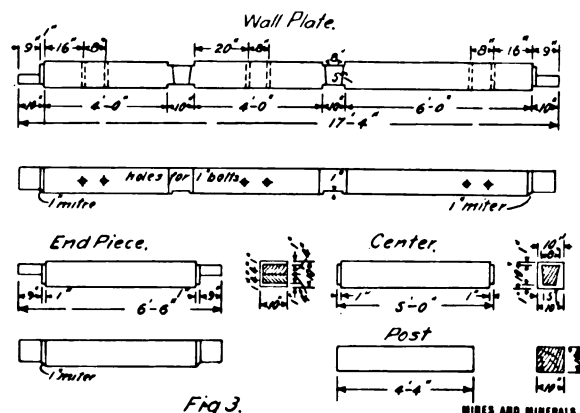


granite is filled and also to all exposures in drifts or other mine openings, causing a peeling of the walls that necessitates close timbering. The filling of the old workings even is affected and in some cases it has altered the granite fragments so far that their clayey state affords little support to the vein walls.

The productive copper veins fill a series of parallel fissures in strike easterly and westerly and in dip varying from the vertical to 65°, with the majority about 75°. The veins themselves are

replacement fillings of the fissures, the mineral matter often impregnating the walls, so that while the veins proper are 5 feet to 40 feet in width, 100 feet and over is often profitably extracted. The chief sources of the copper are chalcocite, bornite, enargite, and chalcopyrite, while hematite, malachite, and other oxidation products of iron, copper, and zinc occur near the surface; pyrite, sphalerite, and some rare minerals occur as accessories below, while around all is a quartz gangue.

The leading companies of the district are the Anaconda, owning the Anaconda and the Syndicate groups; the Boston and Montana, with its properties lying east of the Anaconda group; the Rarus, adjoining the Boston and Montana; the Parrot, owning the Parrot and Bellona mines; the Butte and Boston, owning, among a large number of claims, the Silver Bow, Blue Jay, and Gray Rock; the Colorado Co., owning the Gagnon group; and W. A. Clark, who owns the Original, Stewart, and Colusa Parrot. All of the above operators have their own reduction works, and each of the first mentioned four has mines producing 500 to 1,000



tons of shipping ore per day through one shaft. The shipments are divided into first class, or smelting ore containing less than a certain per cent. of silica, and second class the balance of the ore that it is profitable to handle. The first class ore is usually kiln roasted and treated in blast furnaces for a 50% matte, while the second class ore is concentrated by water, the concentrates being roasted in some type of mechanical roaster and then smelted for 50% matte in a reverberatory furnace.

Shaft Sinking.—Some companies do this by contract and some by day's pay. For the large three compartment shafts four miners per 8 hour shift are employed, working either double handed or by air drills. A typical example of the double-handed method was the 3 compartment shaft of the Bellona mine, sunk 500 feet from the surface by contract in the summer of 1898. The price paid the contractors was \$21.50 a foot, all supplies (including framed timber) except powder were furnished by the company, and the hoisting was done free. The shaft was 7 ft. × 20 ft. in the clear and the speed of sinking was as follows: 1st 100 ft. in 29 days*; 2d 100 ft. in 30½ days; 3d 100 ft. in 33 days; 4th 100 ft. in 36 days; 5th 100 ft. in 39 days.

The holes were put in as shown in Fig. 1. The holes marked 1 were the center cut and those marked 2 and 3 the end holes. The usual number of holes was 16 as shown, but 18 were sometimes needed and occasionally 12 to 14 sufficed. The whole depth averaged 4 ft., and the drilling was done by ¾" drill steel and an 8 lb. sledge. The powder consumed varied from 8 to 9.8 lb. per foot. The procedure was roughly as follows: 1st. shift—drilled center out, blasted and mucked; 2d shift—drilled end holes, blasted and mucked; 3d shift—ditto 1st shift.

A new set of timbers was put in about every 5th shift taking usually 8 hours., though it was done in 3½ hours. as a record. The hoisting was done by a small drum hoist and bucket to 200 feet, and for the balance a large flat rope reel engine with cage and car were used.

As an example of air drill sinking—at a certain mine a shaft was to be sunk from a drift on the 1,000' level, some 1,200 feet from the main shaft. The shaft was 7' × 22' in the clear and the contract price was \$22.50 per ft., the company to find air drills and all supplies, but the contractors threw up the contract and it was finally completed at \$25 a ft. The lack of any ventilation except the exhaust of the air drills, and the large amount of water to pump were the factors that caused the large expense.

The plan usually pursued for air drilling is as follows (Fig. 2): Two machines are used the bars being set up respectively at A and A', B and B'. From 14 to 16 holes are usually

* The day given consists of 12 man-shifts.

needed varying in depth from 4 to 7 feet according to ground, rows of holes 1 and 3 being omitted in easy ground and row 3 being used only for very hard rock. Rows 1 to 3 are the cut, and rows 4 to 5 are the end holes. One order of procedure is roughly as follows with three 8 hour shifts of 4 men each. Shift No. 1, Drill whole round and blast cut; Shift No. 2, Clean up cut and blast end holes; Shift No. 3, Clean up end holes; Shift No. 1, Put in one set of timber; Shift No. 2, Drill whole round and blast cut; etc. The shaft timbers are framed to fit on the surface (Fig. 3 shows the timbers of the E. Gray Rock Shaft) and sent down ready to go in. No nails or spikes are used for fastening, except the screws in the guides.

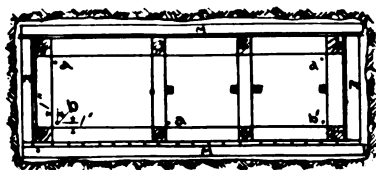


Fig. 4.

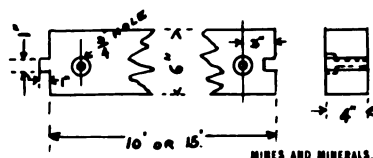
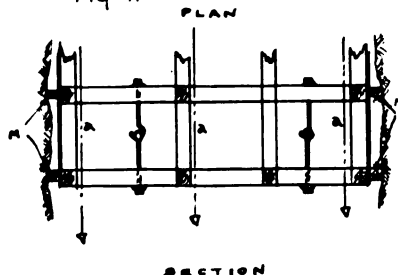


FIG. 5

from bottom of shaft. The guides, Fig. 5, of Oregon fir are fastened to wall plates by $\frac{1}{2}$ " $\times$ 7" brass lag screws or by $\frac{3}{4}$ " $\times$ 7" steel screws where shaft water is not coppery. They are put on in maximum lengths of 15' and are inspected and oiled once a week. The oiling by black oil increased their wear at the Silver Bow No. 1 mine from a year to over 2 yrs, the oil preventing the cutting of both guides and cage shoes by the grit. The plumbing of the shaft guides is done by either of three methods, by the three lines *a, a, a*, Fig. 4 by the four lines *a, a, a, b*, or by the five lines *a, a, a, b, b'*. The plumb bobs, with lines up to 100 feet long, are hung on blocks from one of the top wall plates and take the position in relation to the set corners shown in *b* Fig. 4 when the set is correctly placed, vertical slits $\frac{1}{8}$ in. deep having been sawed, when framing the timbers 1 in. from each plumb line position.

Fig. 6 shows the scheme for partitioning the pump compartment at the 1,600 foot level of the E. Gray Rock for sinking. Fig. 7 shows the guide frame for holding the bucket. Some foremen prefer to use a cage and car for sinking and while this obviates the difficulty of frequent trips and admits of faster hoisting, it requires a large hoisting engine, and unless the cage can be used in the middle compartment of the shaft, the muck has to be shoveled farther to reach the car. Great difficulty has been experienced in keeping a shaft true where it cuts a vein fissure, and numerous smashed cages are the result of any irregularity. "Ease" timbers have been generally adopted to enclose the shaft sets through the bad ground, and at the Bell shaft there are ease sets for several hundred feet. These ease sets, Fig. 8, consist of an outside set placed around each shaft wall plate and braced against it by the girts *A*. As the ground moves the girts can be altered in length to keep the shaft sets true. The lagging outside of the ease sets is put on without nails, like that for the shaft sets described above, but as only alternate planks are put in, the loose ground can squeeze through the interstices, and, falling onto the floors placed on girts *A* every 15 feet vertically, can be shoveled onto the cage from time to time by removing some loose lagging of the shaft sets. The shaft set lagging in this construction is nailed to the wall plates. The sinking pump, proportioned to the amount of water to be handled and run by compressed air, is

hung by stanchions to the next to lowest set and has as suction pipe a steel wound rubber hose fitted with a strainer that rests in the sump. Before blasting, the air drills and tools are placed in the bucket and hoisted with the men to the level above.

In the plan (Fig. 9) is shown a partitioning of the pump compartment used at the High Ore and other mines; one division contains the column pipes and the other is fitted with guides on which runs a repair cage, operated by a small independent hoist on the surface. Fig. 9 also shows the connection between the shaft and the station timbers. The size of the stations themselves depends upon the size of the ore body, on the level, the presence of pumps, and the heaviness of the ground. They are usually the same width as the shaft and 9 ft. high, while the posts in a direction perpendicular to the length of the shaft are the same distance apart as in the drifts. For station roofs of 10 to 12 ft. span, 12" $\times$ 12" caps are used (or in heavy ground 12" $\times$ 18" caps). For spans above 12 ft. the variations of tunnel sets shown in Fig. 11 and Fig. 12 are used.

Development.—The shafts are placed 800 to 1,500 ft. apart according to the size of the ore bodies, the ease of maintaining levels to the size requisite for horse or mechanical haulage, and the facility of railroad shipments from shaft locations. The shafts are practically all sunk vertically in the foot wall, which system admits of rapid hoisting, and with such steep dips the cross cutting needed to strike the veins is moderate (at the Blue Jay where there is a 74° inclined shaft with a cage running on rollers on 4" $\times$ 6" wood guides, the guides are worn very fast and the hoisting is slow). From the shaft cross cuts are run north and south to strike the veins. The drifts in veins under 20 ft. wide are run in the vein, and for wide deposits, as in the Anaconda and West Colusa mines, they are run within the foot wall.

Cross Cutting.—The cross cutting and drifting is done by air drills on days pay for 10 hour shifts, though for rush work three 8 hour shifts are put on. The placing of the holes is shown in Fig. 13 for the 12 hole system; for most rock nine holes are ample, the center holes of rows 2, 3, and 4 being omitted. For this arrangement the drill bar need only be set up once vertically as shown. The round of holes is usually loaded and fired at one time and goes off in the order 1, 2, 3, 4. Some of the miners regulate the explosions by cutting the fuse of different lengths and spitting them simultaneously while held together in the hand, and others by cutting all the fuse of the same length and spitting it separately in the required order. The granite in the cross-cuts is usually self-sustaining and the only timber in them is the ties

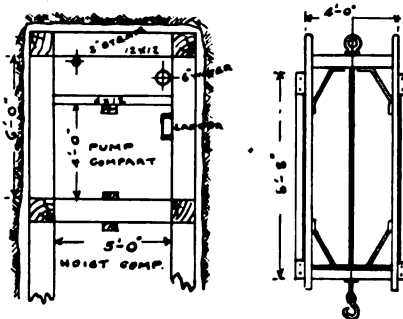


FIG. 6.



FIG. 7.

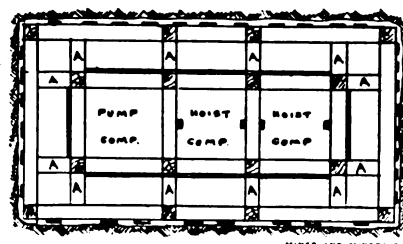


FIG. 8.

of 6" $\times$ 8" sawed fir, placed 3 ft. centers; if seams are cut the timbers are the regular drift sets.

Drifting.—The breaking of the ground is the same as in cross-cutting, but the drifts are all closely timbered with square sets; the posts are placed 5 to 5½ ft. apart, and half this distance in very heavy ground. The sets are shown in Fig. 14. The method of inserting is as follows: The sub-sill of odd blocks is first set to grade by a straightedge and level, the sill laid on it, and the floor girts inserted. The posts are then set up and the cap put on;

after wedging them true against the sides and the back the top girts are put in place. The lagging is then put in on back, and at sides if necessary, and dirt filled in behind it. For lagging, round unbarked fir or pine poles 3 to 6 in. in diameter are used except where there is to be stoping overhead, in which case $2'' \times 10''$ plank is used for the back; the floor and the track are then put down. The sets are kept within 10 feet of the working breast and a rise of $\frac{1}{4}$ of 1 per cent. is the average grade from the shaft. The completed timber section is shown in Fig. 15. A drain is left under the sill center and the water from it on reaching the shaft is taken down the pump compartment to the nearest pump by a square wooden drain box. For drifting through running ground, which occurs occasionally, $4'' \times 6''$ spiling is driven ahead over cap of last set, as face is advanced (Fig. 16), until the next set ahead is put in. Then the spiles are blocked up above the cap so that the next series can be driven under them, or the spiles are removed and $2'' \times 10''$ plank substituted. A similar method is pursued in reopening a drift under a stope that has been worked out and filled in, the old timber having to be cut away in addition. Great care has to be exercised to prevent a slide of the old filling, as such an accident is difficult to remedy. The speed of drifting varies with the ground and the manner of working. In the Butte and Boston mines, where the drifts are run by machines and the machine men do their own timbering, the advance varies from 30 to 70 ft. per month; while in the cross cuts with no timbering to do the advance is from 45 to 85 ft. per month. These results are obtained by working 25 days a month with two 10 hour shifts of 2 machine men each; the men do their own shoveling and shove the cars a mean distance of 120 to 700 feet.

Raising and Stopping.—Where the vein is productive, raises are put in every 50 to 100 feet. They are usually 2 sets wide; a manway set for the ladder and the timber chute, the other set is the ore chute. Two ore chutes are put in for wide veins with the manway set in the middle. If the vein is wide enough the raises are carried up in regular square sets, the sets being stepped off towards the foot with the dip of the vein, Fig. 17. The raise sets are the same dimensions as the drift sets, except they are a foot less in height. Stopping can commence in both directions along the strike of the vein as soon as the first raise set above the drift is put in. The chutes are usually put in along the foot wall and stoping for several sets into the hanging can be conducted without trouble. The stope sets are floored over with $2''$ plank and the dirt broken at the face is carried by wheelbarrows and dumped into the chute. As soon as one floor is worked out to the next chute, the flooring is pulled up and used above, and the space filled in with waste from the stopes overhead. The square set system permits of each set being considered a unit,

best practice to leave a pillar *P* (Fig. 18) 6 to 8 ft. below each drift in the vein in order to simplify the maintenance of the drift, as the pillar is easily robbed on abandoning the level. For veins too narrow to admit of the regulation $4\frac{1}{2}$ ft. in the clear, the caps are shortened to $3\frac{1}{2}$ ft. in the clear. Commonly, inclined sets are used as shown in Fig. 20, the sills *B* and *A* being placed perpendicular to the foot wall for the flatter veins. For hard foot walls the foot wall posts are omitted and in some cases only stulls need be employed. The disadvantage of these inclined stulls is the slanting floor that interferes with the wheelbarrow tramming. If only slightly slanting this is obviated by setting the lowest plank horizontal as at *K* (Fig. 21) or if more slanting the whole floor is made horizontal by blocking as *L*, Fig. 21. There must always be left $2\frac{1}{2}$ ft. inside of timber to pass the wheelbarrow. Where square sets are used it is often best to angle brace with *C* and *D*, Fig. 22, and if ground is heavy a counter brace *XY* is needed to prevent collapsing. The cap is usually all one piece, the butt caps *A* and *B* being used only when they are to be replaced by regular caps after further stoping.

The stoping is all of the "back" variety, and each floor is kept at least 2 sets ahead of the floor above. Air drills are used for stoping wherever the vein is 2 sets or more wide and where the larger blasts will not mix the ore and waste too much. Fig. 23 shows the manner of attacking wide stopes, the heading *A* being first driven by one machine. *B* and *B'* are then kept two sets behind *A* by two gangs while two more gangs *C* and *C'* can drive their stopes 2 sets behind *B* *B'* respectively and so on across the stope. The extra filling needed for wide stopes is taken from the crosscut driving, or even from old dumps or special underground country rock excavations. By single hand drilling, two men can easily break and muck $\frac{1}{2}$ set, or 100 cu. ft. of rock per shift, with a wide well seamed vein.

Winzes.—Winzes are seldom used in Butte, for on account of the water to be pumped and the rock to be hoisted they are more expensive than raises. Sometimes, however, where it is wished to explore an ore body below a drift, and there is no drift below to raise from, a winze is sunk on the vein to develop it. In such a case a Bacon timber hoist is set up in the drift above and a steel bucket on skids hoists the dirt excavated. The winze sets are commonly of $8'' \times 8''$ timbers framed as is customary for small inclined shafts.

Hand Drilling.—Since the introduction of air drills double handed drilling is rare, machines being employed for wide, and single handed drilling for narrow stoping and development. In the average Butte rock 2 men single handed do as much as 3 men double handed; double handed being only an advantage in hard rock where 2 men do 2 to $2\frac{1}{2}$ times as much double handed as single handed. In single handed drilling each miner is

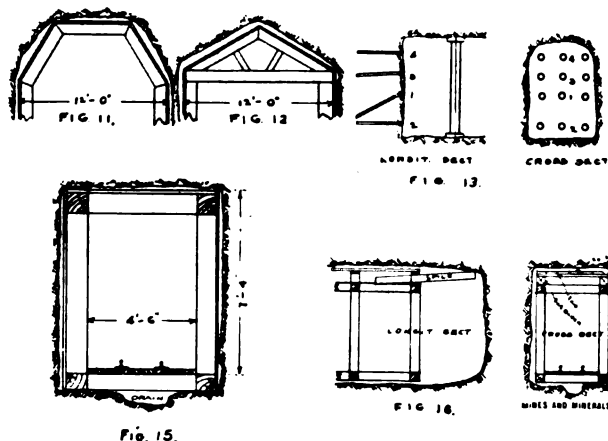


FIG. 15.

so that where too low grade the face can be abandoned without interfering with the discovery and extraction of good ore beyond, which will be reached from another floor. Thus in Fig. 18 (where *M* denotes manway and *C* a chute) the spaces *A* and *B* between the two raises proved barren while the remainder has been removed. A plan of the floor Fig. 19, shows an omission of the barren rock in spaces *D* and *E*. It is considered the

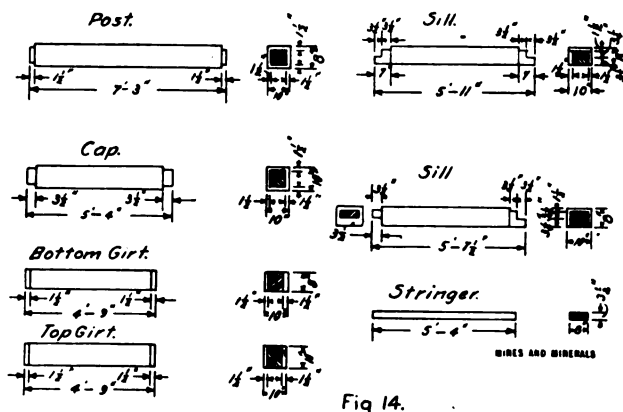


FIG. 14.

allowed 12 to 15 drills per shift as an average, the drills varying in length from $1\frac{1}{2}$ to $4\frac{1}{2}$ ft. and being of $\frac{1}{4}''$ octagon steel. The hardest rock encountered is pure quartz, and the next sound granite; one man can drill 5 ft. of flat holes per shift in average ground and 12 to 14 ft. in easy ground. About twice this distance of uppers can be drilled as in flat, and in down holes the sludge reduces the speed. A leather shield protects the driller's hand

for wet holes. For hard ground the holes are 2½ ft. deep increasing in depth to 4 ft. for very easy breaking ground. Fig. 24 shows the manner of drilling for a typical narrow vein stope, where the first and second class ore lies in separate streaks. The holes are drilled and blasted in the order shown

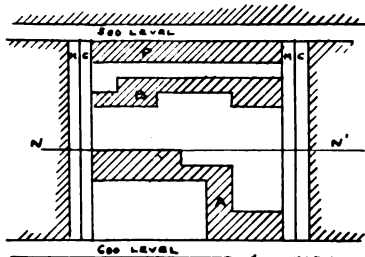


FIG. 18. (LONGIT. SECT.)



FIG. 19. (SECT. OF NN')



FIG. 17.

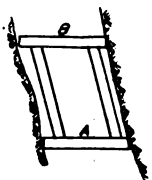


FIG. 20.

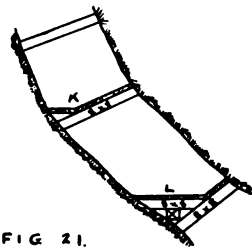


FIG. 21.

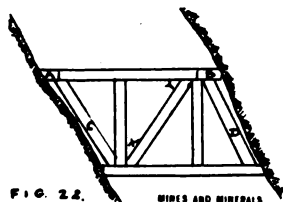


FIG. 22.

the second class being cleaned up before the first class is blasted. The holes are cleaned before loading by the customary long spoon.

Machine Drilling.—The Anaconda Co. uses the Ingersoll-Sergeant, and the Boston & Montana the Rand drill, the No. 300 sizes being employed for all purposes. For stoping and raising where the holes are mostly uppers the drill is set on a tripod, for the shafts, drifts, and winzes, the bar is used. The only duplicate parts kept underground are the side rods and springs, to replace other breakages the machines are sent on top. The life of a machine depends on the shell and that averages in Butte 3 to 4 years. The number of bits allowed per shift averages 12 to 15 of 1½" shank of the X type. The speed of drilling is 80 feet in easy, 40 feet in average and 32 feet in hard ground. Before loading, the holes are cleaned with a sound pump consisting of a ½" rod with a rubber ball on end working tight in a 1" steel pipe. The drill bits are thrown when dull down the timber chutes and collected in the drift by the tool boy, but in the Leonard mine the miners bring them to the station at the close of each shift, thus preventing the loss of tools that formerly occurred in the wide stopes. The sharpened bits are left by the tool boy on the station, at each level and thence procured by the miners.

Powder.—40% dynamite from California is used, the ½" dia. for the hand, and the 1½" dia. for the machine holes; it is fired by the ordinary fuse and caps, miners preparing their

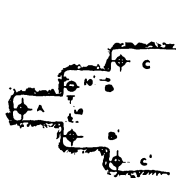


FIG. 23.

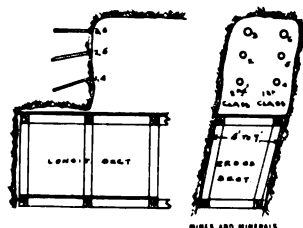


FIG. 24.

own cartridges. For wet holes the top of cartridge over the cap is covered with axle grease and the paper wrapper tied tightly around it. For tamping, the soft vein clay is used packed down with a 1" octagon stick. Water is all that is used for tamping downward holes. Misfires that cause so many accidents in the Butte district arise principally from 4 causes: I. A previous blast blows off the upper part of another hole, thus taking off the cap, and leaving the residual powder unexploded. II. Frozen powder.

III. A wet cap. IV. Defective cap or fuse (either originally so, or injured during loading). The number of reports is not always a safe criterion, and it is only by examining the hole stumps before beginning to drill that safety is assured. The missed holes are when found freed from their tamping by a loading spoon and a short cartridge with a new cap and fuse inserted is put in, retamped and fired. The temperature as a rule in Butte underground is sufficient to keep powder thawed without artificial heat. At the Leonard mine there is a large central magazine in an old working for powder and another central room for caps and fuse. The powderman carries from the central magazines the explosives to the two auxiliary store-rooms on each level (the fuse room being at least 50 ft. distant from the powder room) keeping in them constantly two days' supply. In the smaller mines there is only the central magazine, and enough to supply one shift is taken and left on each shaft station by the powderman.

Tramming.—The ore before being put into the chutes is selected in the stopes and broken to pieces under two feet diameter. The waste that cannot be used for filling sets below the working is dumped separately into a chute and trammed to fill in a stope below the drift, or even handled on the cage to fill up another part of the mine, or thrown on the surface dump. The construction of a chute is shown in Fig. 25. The carman stands on plank A and with a crow bar raises the plank gate. The cars used hold from 1,500 lb. to 1,800 lb. of second class ore, according to the mine, and are of the standard sheet steel pattern with self oiling wheels of the Anaconda Co.'s patent, or sometimes the ordinary type loose on the axles. They can be dumped in any direction from a turn table on the car truck. In some of the

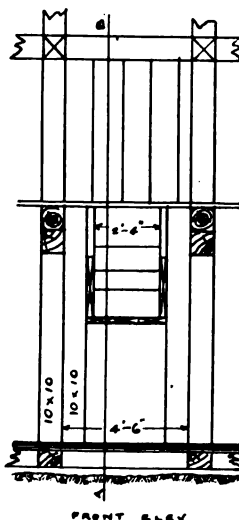
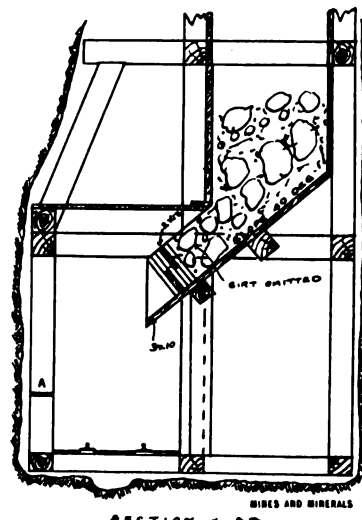


FIG. 25.



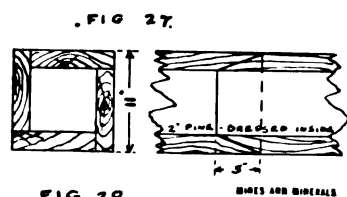
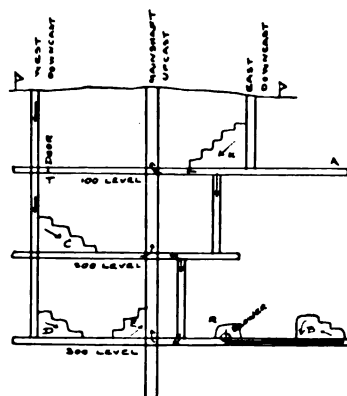
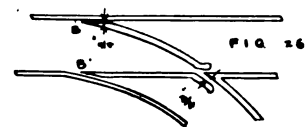
SECTION OF AD.

Anaconda group large cars pushed by two men are used. The track is of 12 lb. per yd. steel T rails usually 20' gauge. It is spiked to 3"×8" stringers in the drifts and to the ties in the cross cuts; no fish plates are used. The shaft stations are always floored with turn sheets of ½"×3'×10' steel, screwed securely to a flat 2" plank floor. The switches, Fig. 26, have no moving parts, the carman jerking the car sidewise to desired track. Horse tramming is employed where the haul is over 500 ft. and there is enough ore to warrant the extra expense of maintaining the drifts to the necessary regularity. The copper water hardens the horses' feet in the Silver Bow mine, so that the hoofs have to be poulticed with linseed and salt for one day each week. A horse will handle 4 to 8 empties and the same number of loads according to grade. On the 400 ft. level in the Silver Bow, where a very steep down grade is encountered for 250 feet, it was found necessary to put in an endless steel rope whose end sheaves were at the side of the track. The upper sheave was provided with a brake wheel, so that the train could be lowered by attaching the cars to the endless rope.

Mechanical Haulage.—A tail rope system was until recently in use on the 1,200 ft. level of the Anaconda mine. This system has now been replaced by a compressed air locomotive with a receiver pressure of 1,500 lb. to 2,000 lb., which seems to have worked well, as several similar ones have been installed elsewhere by the company.

Ventilation.—The system is chiefly natural, and most of the mines are connected to each other underground giving a fine draft. At the face of a drift as A (Fig. 27), the exhaust from the machine drill gives usually enough air. Where a large stope

occurs, as at *B*, and it is impractical to raise to *A*, a blower is placed at *R*, and air is forced through a wooden pipe (detailed in Fig. 28). A similar wooden pipe is used without a blower to ventilate the drift *A* if it is driven by hand, and the end of the wood pipe would for this purpose be flared out to catch the air from the downcast *K*. At the 1,000 ft. level of the Silver Bow mine, a No. 5 Baker blower is run by a Pelton water wheel, turned by drain water piped from the 800 ft. level. As the water would have to descend to the 1,000 ft. level pump anyhow this affects a considerable saving of power.



A downcast raise is usually driven at each end line of the property, and the main shaft being always hot from its enclosed steam column acts as an upcast winter and summer. When a drift is not in use a door *T* (Fig. 27) is put across it to prevent unnecessary short circuiting of air, and trap doors are similarly placed at top and base of the manways. There are two types of downcast intakes at the Parrot mine. The west one is a square steel house, stationary, with a door on each of the 4 sides that can be opened to the prevailing wind, the draft being diverted down by a burlap sheet and the top of the downcast itself covered by wire netting. On the east side, the downcast house is cylindrical with but one door that is turned to the wind by revolving the whole structure on a circular track.

Light.—As is usual in metal mines, the miners use paraffin candles entirely. The drifters and the stopers use 3 to 4 per 10 hour shift and the carmen from 4 to 6 candles per shift, depending on the places occupied. Incandescent electric lights on the alternating current system are used in all stations and along principal drifts; also for the surface buildings. In 1898, in the Parrot mine, the underground stations were illuminated by kerosene lamps hung from a cap. The smaller mines get their electric current from the city wires, but the larger companies have their own independent plants.

(To be Continued.)

The Genesis of Siberian Placers.

The Siberian placers are situated on the north and northeast of a great mountainous plateau. This vast plain, intersected by important rivers—the Wengra, Angara, Yenisei (nearly 3,000 miles long), the Ob (over 2,600 miles), the Lena (more than 2,000 miles), and the Amur (2,600 miles)—still shows traces of great glacial activity. The origin of the Siberian placers, judging from researches made in other parts of the world may be accounted for as follows:

The Silurian or Devonian mud, on account of the auriferous pyrites it contains, most competent geologists agree in regarding as the almost universal source of gold. This was upturned at the period of the formation of the Asiatic ridge, and at the same time was fissured and broken. The fissures, filled with quartz and pyrites torn from the schist by the action of the waters, became the veins already found. Subsequently, the powerful action of the glacial period gave rise to the placers which are now being worked. If this theory of the formation of auriferous alluvia, which has been verified in the other great gold producing countries, prove true of Siberia also, then it is to the south of the localities at present worked that a systematic search for the primitive strata ought to be made. It is known that the Altai contain veins of lead, silver, and copper; numerous specimens of all kinds of minerals have been brought from that region by hunters and foresters. It is in these hills, with their westerly continuations, and in the mountainous mass which strikes out from Manchuria in a northeasterly direction that the wealth of Siberia must be sought.

The chain of the Khingan, "Mountain of Gold," is said to be rich in minerals, and it is doubtless from these hills that the gold in placers of the Ussuri and Amur (lower portion) was brought.—*U. S. Consular Report. Translation from book by Baron de Batz.*

CURRENT MINING DECISIONS.

Prepared for MINES AND MINERALS.

Action for the Conversion of Ore.—Where, in an action for the conversion of ore, an injunction has been issued, in compliance with which the defendant has stored certain ore theretofore mined, it is not entitled to have the value of such ore taken into account in reduction of damages unless it proves such value, and returns or tenders the ore to the plaintiff.—*Montana Min. Co., Limited, v. St. Louis Min. & Mill Co., of Montana*, 102 Fed. Rep. (U. S.) 430.

Vein or Lode Extending under Adjoining Claim.—Possession of the surface of a mining claim is possession of a vein or lode having its apex within the surface lines of the claim, although, in extending downward, such vein may pass beyond the vertical side lines of the claim, and will support an action of trespass for the removal of ore from such vein, beneath the surface of an adjoining claim.—*Montana Min. Co., Limited, v. St. Louis Min. & Mill Co., of Montana*, 102 Fed. Rep. (U. S.) 430.

Grantees in Possession Under Deed Reserving Mineral Rights.—Where a grantor conveyed land containing limestone ledges, reserving from the grant the minerals in the granted premises, and the right to enter to dig and carry away the same, the grantor's heirs are not deprived of their title to the minerals by the fact that the grantees have been in possession, and occasionally burnt a little of the lime deposits on the premises.—*Brady v. Brady et al.*, 65 N. Y., Supp. 621.

Acts Inducing Unnatural Flow of Gas.—Since the right to mine natural gas, where left to the natural laws of flowage, exists exclusively in the owners of superincumbent lands, and such gas is not subject to public appropriation without their consent, they are entitled to preserve it from destruction, independent of the right of the state to regulate it, and may enjoin any act of one owner to induce an unnatural flow into or through his wells which tends to the injury or destruction of the common supply.—*Manufacturers' Gas & Oil Co. et al. v. Indiana Natural Gas & Oil Co.*, 57 N. E. Rep. (Ind.) 912.

Common Property in Natural Gas.—Since the right to take natural gas is common to all surface owners, and the gas does not become the property of any such owners until reduced to actual possession at the surface. Acts 1891, p. 89, prohibiting the use of artificial means to increase the natural flow of gas from a well is not unconstitutional, as a deprivation of property without due compensation, but is a valid regulation for the protection of common property from destruction, recognizing qualified ownership therein.—*Manufacturers' Gas & Oil Co. et al., v. Indiana Natural Gas & Oil Co.*, 57 N. E. (Ind.) 912.

Construction of Reservation of Mineral Rights.—The owner in possession of lands covered with limestone ledges rising above the natural surface of the ground, having some timber thereon and some tillable land, but the chief value of which was manifestly the stone thereon, conveyed the same by warranty deed, excepting and reserving from the grant "all mines and minerals which may be found on the above piece of land, with the right of entering at any time" to dig and carry away the same. Held, that though to construe the exception as referring, under the title of minerals, to the rock, would practically destroy the grant, the exception comprehended the rock, and reserved the title thereto in the grantor.—*Brady v. Brady et al.*, 65 N. Y. Supp. 621.

Allegation of Extralateral Rights.—A complaint which alleges that plaintiff is the owner of a mining claim, and of all the precious metals contained in any vein or lode, through its entire depth, whose apex is within the surface lines of such claim, and that defendant, the owner of a claim which adjoins one of the side lines of plaintiff's, has mined and removed ore from a vein which has its apex in plaintiff's claim, is sufficient, in the absence of a demurrer thereto, to support a judgment in favor of plaintiff for the conversion of such ore, although it does not specifically allege the facts which show that the boundary between the claims of the parties is a side line of plaintiff's claim, beyond which it has extralateral rights.—*Montana Min. Co., Limited, v. St. Louis Min. & Mill Co., of Montana*, 102 Fed. (U. S.) 430.

Deed Conveying Mineral Land Construed.—In compliance with a decree for specific performance of a contract made between the owners of two adjoining mining claims in settlement of a suit brought to determine a disputed boundary between them, the owners of one claim conveyed to the owners of the other the strip in dispute, "together with all the mineral therein contained, together with all the dips, spurs, and angles, and also all the metals, ores, gold and silver bearing quartz rock, and earth therein." Held, that such conveyance had no other effect than to fix the surface boundary between the two claims in accordance with the original contention of the grantee, and did not deprive the grantor of any extralateral rights under the ground so conveyed; such boundary being a side line of its claim.—*Montana Min. Co., Ltd., v. St. Louis Min. & Mill Co., of Mont.*, 102 Fed. Rep. (U. S.) 430.

THE HAILE GOLD MINES

Machinery Used for Concentrating the Ores and for Roasting and Treating Them by the Chlorination Process.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The ore coming from the Haile Mines, described in the September issue of MINES AND MINERALS, goes first to the stamp mill and concentration works, thence to the roasting furnaces, and lastly, to the chlorination works.

A large building containing 60 stamps and concentrating tables also contains a Corliss engine, built in Providence, Rhode Island, and used since May 13th, 1885. A revolution counter records the number of revolutions made per week, month, and year. This engine drives all the machinery in the concentrating works, including the 60-stamp mill and a 350-lightpower dynamo which illuminates the whole plant at night. The same engine supplies power for the diamond prospecting General Electric drill; it keeps 20 Embrey table concentrators, four Triumph concentrators, and 5 Wilfley tables in perpetual agitation.

The ore comes to the mill crushed and is discharged into a bin in the center of the back-to-back stamp mill. The ore is brought in three-ton cars by a narrow-gauge locomotive. The cars discharge from their bottoms into an ore bin built like the gable roof of a house, cone-shaped, so to speak, by which form it distributes the ore to 30 stamps on each side of it; thence it passes into batteries by Hendy self-feeders. The batteries have five stamps to each battery; each stamp weighing 750 lbs. and dropping 90 times per minute. Steel shoes are used. The ore is discharged through a 35 mesh brass wire cloth; then the pulp passes over 8 ft. of silver-plated copper plates coated with mercury. There are four plates to each battery, 50 inches long by 26 inches wide. They are the full width of the mortar and are arranged in four steps, each 2 feet long and overlapping the next by 1 inch, the inclination being 2 inches in 1 foot. They are fastened directly to the battery, the tremor caused thereby being rather beneficial than otherwise to amalgamation. These plates are interchangeable. The advantage of these separate plates is that you only need to remove the top plates for cleaning off, then move the three lower plates forward and the top plate then becomes the bottom plate. Whenever the upper plate becomes hard and unfit for amalgamation, it is cleaned of the amalgam and interchanged with one of the lower plates, thus giving, in rotation to each plate a position at the head of the table. Each battery is provided at the screen discharge with an impact plate, not only for amalgamation, but to retard the velocity of the pulp. The plates are cleaned from verdigris with a weak solution of cyanide, and a little potash is sometimes fed into the battery. Phosphate of sodium is used in the mill to keep the quicksilver bright and lively. The inside plates are removed every 24 hours, as duplicate plates are kept on hand, no delay occurs while they are cleaned. A regular "clean-up" is made once a month.

The cam shaft makes 45 revolutions per minute, the cam being double equals 90 lift-drops per minute. These stamps grind 2 to 2½ tons of ore per day (24 hours).

The life of a shoe is about six months, that of a die the same. The amount of water used per stamp is three and a half gals. per minute; average consumption of quicksilver is 0.35 oz. per ton of ore; wear of shoes and dies is 0.5 lb. per ton of ore stamped. Molasses thickened with flour is used as a lubricant to the cams.

The fineness of the mill gold is 880. The ore of the Cross mine uses the inside battery amalgamator and on these inside plates one-third to one-half of values of free gold is caught, the other half or two-thirds on the outside.

After the free gold has been extracted from the material passing over the amalgam copper plates, the pulp is led through launders, or troughs lined with riffles to the concentrating room, where it is distributed over 26 concentrating tables on a lower floor. The pulp discharges into a box, from which it is led off in small launders onto each table, separately. Little gates open or shut on the launders, regulating the amount of pulp given to each machine.

The ores from the Beguelin and Cross mines owing to the difference in contents of sulphurets are milled separately. The Cross ore averages 2%; the Beguelin 7 to 25% sulphurets. The concentrators are of the belt type; the machines make from 192 to 210 end shakes per minute, the length of the stroke being ¾ inch.

The Embrey tables, of which there are 20, are 12 ft. long by 4 ft. wide with smooth rubber belts, which are set at an inclination of 3 to 4 inches and travel 5 ft. per minute, receiving at the same time 192 percussions. The pulp is distributed within 18 inches of the upper end. The concentrates contain 90% pyrite which is pure sulphide of iron, with occasional small traces of arsenic. The average value of concentrates is \$25 to \$35 per ton.

The Wilfley table is of plain wood, the surface covered with linoleum. On this are parallel strips an inch apart; the motion is lengthwise, 240 shakes per minute. The table is inclined, whereby, when pulp is fed onto the table in one corner, through the motion and parallel strips, the heavy material works down toward the higher point, whilst the light gangue passes over into a tailing sluice, the table being so arranged that at the point where the values are discharged a proportion of it, not being clean, is discharged into a small trough leading to an elevator and returned to the table again.

REVERBERATORY FURNACE ROASTING.

Concentrates are brought from the mill on a railroad running above the top of the reverberatories. They come wet from the mine and lie on top of the reverberatories for drying, then they go down through the top arch of the reverberatory on to the upper hearth. The reverberatory is 45 ft. long by 6 ft. wide inside; 7½ ft. high, a double decked or hearthed reverberatory. The ore is worked forward on top of the hearth till the end of the furnace is reached, when it goes on to the lower hearth. It is then worked to the finishing end of the lower hearth to the firebox, and the finishing roast is made and the ore is withdrawn ready for chlorination. Each time a charge is drawn there is a fresh charge added, keeping the furnace continually filled with ore. The English "pan furnace" is from the Mecklenburg Iron Works; a reverberatory 30 ft. long is attached to this. Ore coming through the reverberatory is partly roasted before reaching the pan roaster. The pan is 12 ft. diameter. It is a cast iron frame lined with fire brick. The trough is built out of brick with a canal in it for discharge. A raker rakes the ore out of the canal into a bin and thence to the cooling floor. The pan is rotated by a small engine and belt just below the works. The sulphur, by means of these furnace roastings, is reduced from about 43% to as low as ½ per cent. and the value of the material increased by ½.

Each double hearth furnace is worked by two men to a shift of 12 hours, the output being 2 tons of roasted concentrates per 24 hours for each furnace. The revolving "pan-furnace" is worked by three men per 24 hours with the same output as the double hearth.

The fumes from these furnaces carry off into the air the equivalent of 13 tons of 50 per cent. sulphuric acid per day. The management have investigated the erection of lead chambers, but so far have not considered such an installation to their advantage. The Spence furnace has been tried at the Haile without success.

THE CHLORINATION PROCESS.

We now come to the chlorination process which is of special interest because Mr. Thies was the first to introduce what is known as the "Thies barrel-chlorination process" into this Southern country.

The roasted concentrates are put on the cooling floor and then by a chain elevator hoisted 40 feet to the top floor of the chlorination building. This building is four stories high, containing three chlorination barrels, 11 filtering tanks, two storage tanks and 13 precipitating vats. The ore is charged by cars holding one ton each, through a hopper into the chlorination barrels. From the top floor the roasted material is charged into a chute leading into lead-lined, iron cylinder barrels, each barrel holding one ton of material; 14 lbs. of lead to the square foot is used for lining. The size of the barrel is 44 inches diameter; 66 inches length, with hole on top capped and lined with lead. It also contains a lead valve in order to ascertain whether the necessary amount of free chlorine is present. The full charge consists of 120 gals. of water (to make an easy flowing pulp), 8 to 11 lbs. of bleaching powder, and 12 to 15 lbs. of sulphuric acid, for treating one ton of ore of 2,000 lbs. The chlorination barrel is then hermetically closed and set rolling 14 to 18 revolutions per minute for about three hours. A 5 H. P. engine performs this work, and also the elevation of the ore. The gold is gradually changed into a chloride. The barrels revolve three hours before the gold is extracted. When the process is completed the barrel is opened, inverted, and discharged through a lead-lined semi-circle, in the floor to a filter on the floor below. There are four lead-lined filters to each barrel, their dimensions being 6 by 8 feet by 18 inches deep in front and 17 inches in the back. The bottom is covered with mineraline tiles 12 by 12 inches by 1 inch thick, perforated and having ¼-inch gutters underneath. On top of these is placed a rack of 1½-inch wooden slats 4 inches high and 8 inches apart to hold the gutter bed in place.

The filter beds consist of 4 different grades of quartz, from ¼" to ¾" and topped off with clean washed sand 1" thick making 5 grades of material. On top of the tiling, strips 4 inches wide, 1 inch thick and 8 ft. long are placed five inches apart for the entire width. The strips are to obviate the destruction of filter beds below in cleaning out the charge after the gold has been chloridized.

The ore pulp discharged in the semi-circle is conveyed through what, from its shape is called a "boot" which distributes it over the filter, built to hold one ton of material. This so-called boot works in a circle, movable from one filter to another. It is so set as to discharge in four filters set back to back.

When ore is discharged from a barrel through the boot onto the filter bed, the material contains gold as chloride; after that the discharge pipe leading to the storage tank is opened and chloride solutions come from the filter in a clean yellow state.

From this tank the liquor is carried by hose through holes in the floor to the different precipitating tanks below. The gold in this liquor as chloride is precipitated into a metallic state by addition of sulphate of iron.

Copperas is made at the works from scrap-iron and sulphuric acid. After precipitation is complete, the tank is allowed to remain undisturbed for three days. The gold has then all settled, and the tank is then ready for drawing off by lead spigots. The bottom spigot is for cleaning out the precipitate.

Before emptying the contents of the barrel, the filter is flooded with water to the level of the top of the filter bed to act as a cushion. The ore pulp is washed twice with clear water. The first time enough water is added to stand 4 inches above the surface of the pulp, and the second time the tank is entirely filled. This amount has been found sufficient to thoroughly remove all traces of chloride of gold from the pulp but repeated tests are made of the pulp.

There are twelve filters, four to each barrel. The chloride solution coming from the filters above is conveyed through separate lead pipes to two storage tanks of 120 cubic feet capacity on the second floor and is drawn off from these into the precipitating tanks as required. These tanks are square, lined with lead, and they settle as well as store the material. The precipitating tanks are eight ft. in diameter, 3 ft. high, and made of wood, the interior being coated with asphalt. They are provided with three outlets; the upper one 18 inches from the top; the middle one, one inch above the bottom and the lowest one in the jamb. The gold is precipitated in the metallic state with an excess of fresh ferrous sulphate made in a small lead-lined tank. In warmer weather 48 hours suffices for settlement and in cold weather from 3 to 4 days. The supernatant liquor is drawn off through the two upper outlets in order to prevent any stirring of the precipitates, and passed through a box filled with sawdust to catch any precipitate.

The gold precipitate is drawn from the tanks through the jamb opening into a small lead-lined settling tank, $2 \times 2 \times 4$ ft. After standing 24 hours the supernatant liquor is siphoned off and the precipitate filtered on paper. This is dried and mixed with about half its weight of borax and soda in almost equal proportions and then refined. Should iron salts be present a little quartz sand is added.

There are 13 large tanks, and two small ones for final clean up. These tanks are filled three consecutive times and precipitated before cleaning out the gold. Then the precipitate from the tanks is put into the final clean up boxes, and is there cleaned up by addition of acid and water from whence it is cleaned up and sent to the refinery where it is melted in graphite crucibles and cast into ingots. The gold coming from this department assays 950 to 995 fine. The extraction is 90 to 95%.

The amalgam from the mill is retorted in a typical retort the same as used in silver mines. A cast iron cylinder has an opening in one end for the entrance of amalgam and at the other end the fumes go out through a pipe jacketed with cold water for condensing them. Bullion is smelted with fluxes in black lead crucibles.

Consumption of Coal in France.

Attention is directed to the increased consumption of coal in France. In 1899 the consumption amounted to 45,600,000 tons, the production being 33,300,000 tons, and the imports 12,610,000 tons. In 1898 the consumption was distributed in the following manner:

	Tons.	Per Cent.
Mines.....	2,860,000	6.49
Metallurgy.....	7,757,000	17.95
Industrial Machinery.....	8,643,000	19.96
Railway.....	5,105,000	11.80
Sea navigation.....	425,000	0.99
Inland navigation.....	37,000	0.09
Works, household, etc.....	18,168,000	42.70

In 1899 the two coal fields of the Pas-de-Calais and the Nord produced together 20,533,671 tons from 124 pits. The Pas-de-Calais produced 14,501,603 tons from 77 pits. The outputs of the largest collieries in tons were as follows: Lens 3,065,611, Courrières 1,930,868, Bruay 1,624,331, Bullay-Grenay 1,486,303, Noeux 1,335,562, Lievin 1,153,512, Marles 1,127,465, Douerges 1,044,240. In the Nord coal field the most productive collieries were, Anzin 3,154,000, Aniche 1,157,412, Escarpelle 724,383.

Care of Boilers.

The question, How to keep boilers clean, is one that vexes all steam users. Scale accumulating in the boiler means a large increase both in the cost of fuel and of the bills for repairs. It takes only $\frac{1}{8}$ in. of scale to require fifteen per cent., and $\frac{1}{4}$ in. of scale to require sixty per cent. more fuel to generate the same amount of steam than with a clean boiler, and as the iron has to be heated to a higher temperature it deteriorates more rapidly. One very common method of overcoming this difficulty is by the use of water heaters.

The "Frontier" heater made by the Ward Heater Co., of Griswold and Jefferson Aves., Detroit, Michigan, is of the open type of heater in which the water is not under pressure, thus allowing certain gases to easily escape from the water.

The heater shell is of $\frac{1}{8}$ -in. iron, and the top and bottom of cast iron. The pans *A* and *B* are of cast iron, as light as strength will permit, and are provided with dams to interrupt the course of the water and expose all of the water to the pans, so that the lime and carbonates may deposit on their way downward. The first pan sets on lugs riveted to the inner shell of heater, with its open edge to the left of door; an *A* pan is next placed in position, with its feet on the upper edge of *B*, and so continuing to the last pan.

The first downward course of the water directs all sand and neutral particles toward the bottom of the mud pot *O*, and all that do not reach the bottom are caught between the mud cells, as they retard the direct outward flow of water. *D* is the outlet to pump for boiler. The inclined sides of the mud pot throw everything to the center, to be blown off as often as required.

There is a large manhole with a self-making joint of square rubber let into a groove in the frame; the door is fastened with bolts, in slots, so that they can be slacked a little, and taken out sideways; this is the only joint made when cleaning, and will last for years.

The water entering the heater is led into the pan *A*, around which it passes through to *B*, and on from pan to pan until it is led by the pipe to the bottom of the heater, in its course being heated by the steam which enters at *F*, till it is thoroughly boiled, and the lime, etc., precipitated to the bottom and sides of the pans. By the construction of the pans the water is continually kept from the direct course of the moving steam, so that the latter cannot carry the water from the heater even though it be overloaded; on the contrary all the wet steam is condensed by contact with the pans and unites with the feed water, and the exhaust passes off as dry steam.

Only sufficient water is admitted to the heater to supply the pump at whatever speed it may run, and enough overflow to carry off the grease and scum. Thus it is economical of heat, in that a large amount of water is not wasted when the pump is running slow. The automatic regulator is simple, has no parts to get out of order, never fails to act promptly. By this overflow at intervals the oil and scum are being continually drained off the top of the water.

A school has been established by the government at Fort Monroe, Va., for the purpose of instructing regulars in the application of electrical machinery used in the army. The rules, published by direction of the Secretary of War, provide that applicants must be under 25 years of age, unmarried, qualified as a gunner, a student of a correspondence school or the owner of electrical books, and no applicant will be recommended unless he has sought for a year or more to become practically familiar with one or more classes of electric machinery or with some portion of the elementary literature on electricity.

ELECTRIC PLANT

At Windber, Pa. A Description of Generating Plant and the Methods of Wiring, Operating, Etc.

By A. S. McAllister.

The modern coal mine bears little resemblance to its predecessor. Increased demands for fuel have required increased rapidity in the methods of handling coal, while business competition has necessitated increased economy in mine operation. The results are that the miner's pick is giving way to machine cutters and the mine mule is sharing the fate of the street-car horse.

In the selection of equipment for mechanical mine operation there enter three factors requiring careful consideration. The first and most important is that of reliability of service; second, flexibility of system; third, cost of equipment and maintenance. At the Windber, Penn., mines of the Berwind White Coal Mining Company can be found one of the most extensive and modern soft coal mining equipments in the world, and here the three requisites just mentioned have been secured by means of electrical and mechanical equipment. Although only two years have elapsed since the first mine was opened, the daily output has reached almost 10,000 tons.

The mines are known as Eureka Nos. 30 to 38, inclusive. The coal lies in what is known as the Miller seam, which at that locality has a thickness somewhat less than 4 ft.

As far as is economically possible, all handling of the coal is done by machinery. Power for operating the mines is derived from batteries of Sterling boilers located at each mine. Capell ventilating fans are driven by steam engines. Ingersoll-Sergeant compressors supply air at 75 lbs. pressure for operating the pumps and coal cutters; 550-volt locomotives are used for haulage, and current from this circuit is used also for lighting the power houses and tipples, as well as the mine proper.

The Phillips tipple equipment used here is the latest type of self-dumping apparatus.

Where the boiler house is situated near the drift mouth, the direct use of steam engines to drive the ventilating fans, avoiding double transformation, possesses obvious economical advantages and this plan is followed. For driving pumps, compressed air has been found to give entire satisfaction. Air pumps require an extremely small amount of attention, and an accidental stopping results in nothing more serious than freezing up. Air coal-cutters are used because they are capable of withstanding all kinds of usage at the hands of inexperienced operators and possess the additional advantage of supplying fresh air at the face of the coal working.

In comparison with electric cutters, air machines are more wasteful of coal and more expensive to supply with power; moreover, pipe lines for compressed air are expensive to install and are usually found unfit to transfer to new openings after having been in use for some time. It was thought, however, that the great reliability of operation and the ease of control by untrained hands more than compensated for these disadvantages.

The first power equipment for electric haulage at Eureka No. 30 included two General Electric 150-kw. 550-volt generators

belted to two 242-h. p. McEwen engines. Increased development soon rendered a third generating unit necessary, and a 150-kw. Thompson-Ryan dynamo was installed. The resistance of the series coils of this machine being much greater than that of the series circuits of the General Electric generators, part of the Thompson-Ryan coils were left outside the equalizer circuit, only as much as were required to equal the resistance of the series circuits of the G. E. dynamos being included between the equalizer connection and the brush. Though of doubtful utility when applied to an ordinary compound-wound generator, this method has given good satisfaction with the machine mentioned. This arrangement is more clearly shown in Fig. 2.

When Eureka No. 31 became sufficiently developed to justify the substitution of electric for mule haulage, a power line was constructed to that mine from No. 30, a distance of 5,340 feet. With a view to future use of the material No. 00 hard-drawn bare copper wires, similar to those in the mines, were used for the transmission circuits.

Eureka No. 32 is situated 6,900 feet from No. 31. Though this mine now has its own power plant, it was considered economical in its earlier existence to transmit power from No. 30. The resistance of the circuit was about 1.67 ohms, one positive wire being run from No. 30 to No. 32 and the negatives from No. 32

connecting to the two negatives to 30 from 31. Though even the maximum short-circuit current at No. 32 could be but little in excess of 300 amperes, it was ascertained that the line was amply sufficient to supply power for one locomotive. Running on this high resistance was but little worse than the use of several sections of the rheostats, as is necessary with the locomotives at the other mines. On account of the intermittent character of the work of each locomotive, the use of two of them at No. 32 caused very few delays on the part of either, though only one could be using current at any given time. Each motorman could easily determine by the brilliancy of the headlights when



FIG. 1. VIEW SHOWING PECULIAR OVERHEAD CONSTRUCTION.

the other locomotive was in use. The establishment of a power house at Eureka No. 32 eliminated this arrangement. It contains two 150-kw. 550-volt General Electric generators direct-connected to McEwen engines. When these units were installed the number of locomotives in use at No. 30 and No. 31 had so increased as to over-burden the three generators at No. 30, so No. 32 was depended upon for assistance. By short-circuiting a portion of the shunts to the series coils of the generators at No. 32 so that they compounded from 500 to 550 volts at full load instead of from 500 to 600 as when first set up, and by altering the transmission circuits so that No. 32 was connected to No. 31 directly through a pair of No. 00 conductors, a fairly satisfactory supply of power for No. 31 was obtained when the generators at No. 30 and No. 32 were operated in parallel.

As now connected the resistance of circuit from No. 31 to No. 32 is 1.07 ohms. With a circuit resistance of .4 ohm between No. 30 and No. 31 and the two power plants running at the same bus-bar voltage, any demand for current at No. 31 is met by the power plants in a somewhat greater proportion than the inverse ratio of these resistances, provided neither No. 30 nor No. 32 mine is using current at that moment. By decreasing the compounding of the generators at No. 30 from 500-550 to 500-525 volts a most satisfactory service for No. 31 has been secured.

* Reprinted through the courtesy of the American Electrician.

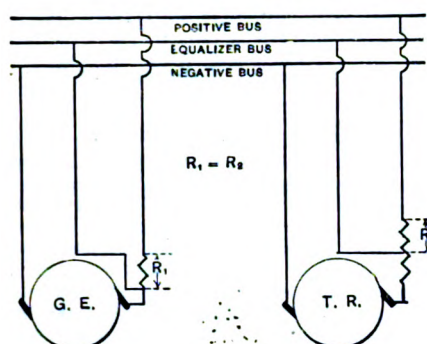


FIG. 2. SPECIAL EQUALIZER CONNECTION.

In the early stages of the development of No. 35 a transmission line was run from No. 32, which line now is used only when it may be economical to run only one of the plants. The two plants cannot be run together as is the case with Nos. 30 and 32. Eureka No. 36 is supplied with current from No. 35.

Power for Eureka No. 34 is transmitted over four No. 00 conductors a distance of 2,540 ft. from Eureka No. 33, where are installed two 150-kw. Thompson-Ryan direct-connected generators. By setting the generator circuit-breakers at 475 amperes it is practicable to supply sufficient power to run four locomotives at the two mines with either generator. Some idea of the nature of the demand for power for electric mine haulage may be gained from the fact that, though each locomotive will require, as a maximum, over 300 amperes, 475 amperes will be adequate ordinarily for four locomotives, and six locomotives will seldom require over 600 amperes.

At Eureka No. 37 have been installed two Thompson-Ryan 150-kw. direct-connected generators, and provision is made for a duplicate equipment. The locomotives at Eureka No. 38 will be driven by power transmitted from No. 37.

As has been intimated, No. 00 hard-drawn copper is used for trolley wire. The line construction throughout is of the most substantial nature. In all cases, however, due regard has been had for the fact that numerous changes of location are necessary, as the coal bed becomes worked out. Soldered trolley wire clamps are unsuited to this class of work. Only those providing purely mechanical means of gripping the wire have been found to give satisfactory service.

The locomotive trolley poles must be of such a length as to be easily reversible on a single-track entry, and this sets a limit to the height of the trolley wire outside the mine. The external wiring is supported 7½ ft. above the rails through cap-and-cone insulators by 1½-in. pipe and pipe hangers. The side poles are set 20 ft. apart on each side of the track and 3½ ft. from the rails. To these the pipes are secured by means of cast iron side brackets held in place by ½-in. × 3½-in. lag bolts. See Fig. 1.

Inside the mine the wire varies in height from 39 in. to 7½ ft. The most satisfactory method of suspending the wire from the roof is by means of cast-iron wedges and bolts. For this purpose there are drilled in the roof 1½-in. holes, 6 ins. deep, spaced about 20 ft. apart on straight track and 12 ft. on curves. In these

Quite noticeable in this method of paralleling compound-wound dynamos is the fact that, all other conditions being the same, one generator running at No. 32 supplies more current to No. 31 than both generators do when running connected in parallel.

Power for electric haulage at Eureka No. 35 is developed by three Thompson-Ryan 105-kw. direct-connected generators.

holes ¾-in. × 7½-in. bolts with hexagon heads are secured by means of two roof wedges. Each wedge has a concave inner surface to surround the bolt and convex outer surface to fit the side of the hole when driven home.

The end of each stretch of wire is securely anchored to a special form of roof bolt through a strain insulator and turnbuckle. The use of 18-in. turnbuckles has rendered unnecessary any auxiliary tools for obtaining the required tension upon the wire.

At the air passage overcast on each side entry there is placed a section insulator and switch for disconnecting this section of wire from the rest of the mine in case of accident or extension of the trolley line. Though many types of section insulators were tested none was found which, when exposed to the accumulating moisture of the mine, would not allow the current to leak across in sufficient quantity to render the handling of the partially-insulated wire at least disagreeable, if not dangerous. Application of the scheme of opening the insulator switch and connecting the trolley wire to the rail removes all trouble from leakage currents and has an additional advantage of securing safety from an accidental closing of the switch.

The tracks are laid single on the side entries and double on the main entries. The two main entry wires are interconnected

at each side entry cross-over track. The large amount of conducting material in the main entry obviates the necessity of auxiliary feeders to any portion of the mines; 30-pound T-rails are used on all tracks traveled by the locomotives. On the main entries all four rails are bonded, though the bonding of one rail is considered sufficient for the side entries. The bonds are of No. 00 soft annealed copper secured to the rails by ¾-in. channel pins. It is necessary to use the greatest care in order to obtain good bonding in this way on such a system as the one under discussion.

The effect of electrolysis is quite noticeable, especially upon the water pipes, a case being recalled where a certain section of

pipe required a new union about every three weeks on account of "rust." A slight change in the channel pins by which the concave portion next to the wire could not offer a cutting surface as at present would undoubtedly decrease the number of bonds quite often carelessly sheared. At each mine is located a locomotive house of sufficient size to shelter six locomotives, with pit space for four. The houses are heated by steam and lighted by electricity. The pits are five feet deep and well drained. A 6,000-lb. Harrington chain hoist serves to handle the motors and axles when repairs become necessary.

Two general types of locomotives are in use at the different mines; the General Electric 13-ton, draw-bar pull 3,000 lbs. at

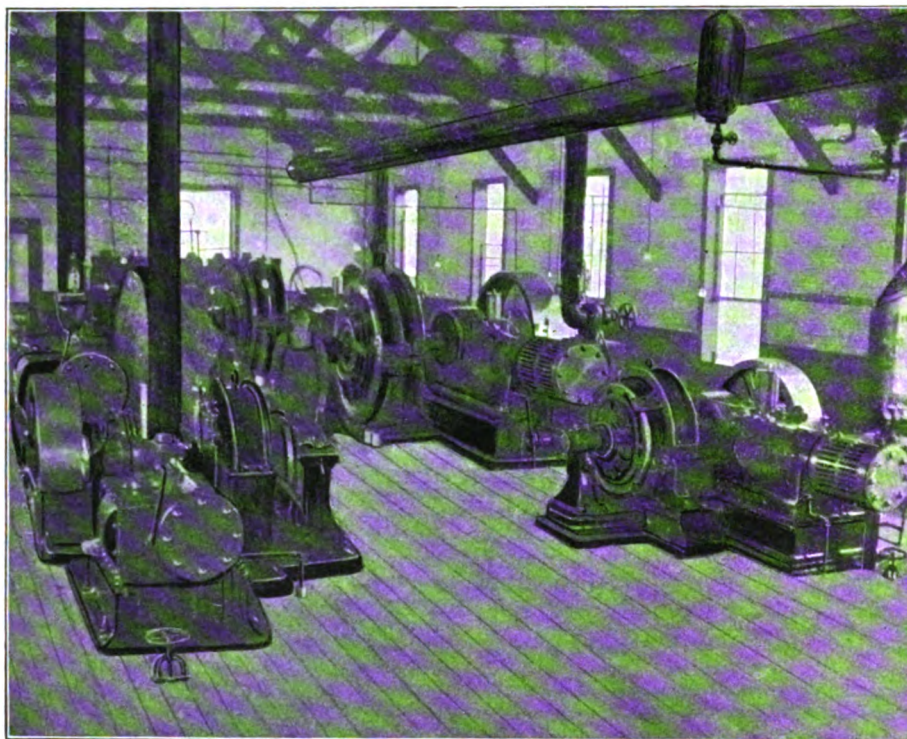


FIG. 3. GENERATOR ROOM AT EUREKA NO. 35.

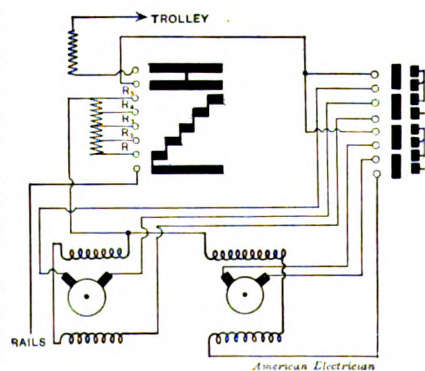


FIG. 4. CONTROLLER DIAGRAM.

8 miles an hour, and Baldwin-Westinghouse, 26,000 lbs., with a speed of 8 miles an hour.

All of the locomotives in use here are equipped with magnetic blow-out rheostatic controllers, the two series-wound motors of each locomotive remaining always in parallel, and the various speed changes being governed by adjustable resistance in the power circuit, as indicated by the controller diagram, Fig. 4. If it were possible always to run the trips at the maximum speed of the locomotive, this method of control for such service could not be improved upon. Experience, however, has shown conclusively that the trips can very seldom run with safety at such speed and that the major portion of the hauling is done on two of the four sections of the rheostat. Nine-tenths of all electrical trouble experienced with the locomotives at Windber has been due to this fact. A system of control so designed that the light load hauling, switching and trip gathering could be done with the motors in series and the straight track hauling with the motors in parallel would be found much more satisfactory for this class of work.

On account of the motors being always in parallel a mere shifting of the reverse lever when the locomotive is in motion results in an almost immediate stop of the locomotive, due to the generator action of the motors; this effect being independent of any connection to the trolley line. Though this action is of inestimable value when used as an emergency brake, the knowledge of its availability on the part of the motormen has rendered them more careless and resulted in the destruction of many gear wheels. Reversing the motors and throwing the controller lever to the first position has been found to give equally good braking and to have a cushioning effect on the gear wheels.

The slow speed at which much of the heavy hauling must be done has been commented upon. To return the controller lever to the "off" point with a heavy current passing, such as is required, invariably results in vicious arcing at the controller

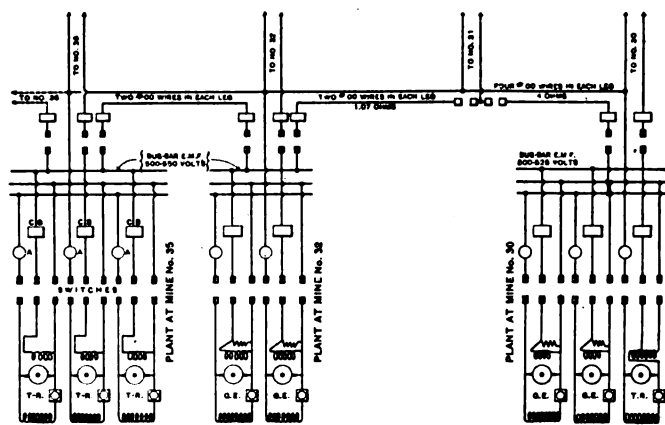


FIG. 5. DIAGRAM OF ELECTRICAL CONNECTIONS BETWEEN THE THREE GENERATING PLANTS.

tips, which soon carbonizes the insulation. It frequently happens, even, that an arc from trolley to ground in the controller occurs, which obviously throws circuit-breakers and entails delay. In order to obviate this source of trouble the following method of using the controller has been adopted:

If it becomes necessary to throw the controller "off" on a heavy haul at slow speed, first throw the lever forward till the drivers spin, then quickly throw to "off" point. This never fails to give the desired result; that is, a reduction of sparking. The prolonged high speed of the armature generates sufficient counter E. M. F. to reduce the current to a value at which the circuit may safely be opened.

Power for lighting the mines is taken from the haulage circuit, five 110-volt lamps in series being used at the main entry cross-overs and two 275-volt lamps at the single switches. All light and signal circuits are of No. 12 insulated copper wire supported on porcelain knobs secured to wooden plugs in the roof.

There can be no doubt that, with such extensive mine operations as at Windber, polyphase currents for pumps and cutters would be found much more satisfactory and economical than compressed air. The use of 500-volt generators supplying both direct current for the haulage locomotives and polyphase currents for induction motors would, by proper disposition of circuit-breakers and fuses, prove the most economical system for mine equipments, and it seems reasonable to expect that such a plan will be adopted sooner or later.

EXPERIMENTAL ORE TESTING WORKS.

Means for Determining the Proper Method to be Used in Treating Ores From a New Mine—Importance of Tests.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

There are certain problems that are almost sure to come up with parties who own a prospect or a young mine. They have the mine or prospect examined by an expert. He takes his samples of the veins or vein in the usual way. If the vein is developed along a tunnel or drift he may take his samples across the vein at every ten or twenty feet and after quartering, etc., average up the whole result, but this at best gives but an uncertain and only approximate idea of what the true value of the vein as a whole is. What is desired is to know what it will run day in and day out on an average, and this the assay will rarely prove, or at best only very approximately. In another case the property containing several veins may only be developed by a cross-cut tunnel, cutting across the several veins. On these there may be little or no development and the expert has only a chance to take one assay sample on the face of the vein where it is cut by the tunnel. This gives a very inadequate idea of the possible value of the vein.

Now, what the owner wants, is to have mill runs made of much larger samples than the assayer's—500 to 1,000 pounds at least, or even tons and car-load lots. These, too, should not be taken all from one spot, but if the development is sufficient, at intervals, say of over 100 or more feet apart. This certainly should be done before expensive works or mills are contemplated. Having then obtained a fairly good idea of the quantity and quality of the ore by these large mill tests, another and very important problem arises, viz.: what will be the best process for treating these ores, shall it be smelting, stamping, concentrating or cyaniding? Many a mine and mill has failed from a choice of a process unadapted to the ores. The need felt on this subject has led to the establishment in Denver and elsewhere of small experimental plants whose sole purpose is that of trying large samples and deciding what milling or other process is best adapted for their treatment. The following is an account of a personal visit to the ore testing works of Henry C. Wood, in Denver: The works are located on the Denver & Rio Grande R. R. tracks within the city limits of Denver and are easily reached by electric car line. From the works is a fine view of the distant mountains. The building is three stories high and 100 feet long and 40 feet wide. Railroad track scales weigh the ore on receipt. There are 20 ore bins into which the ore is discharged, giving a total storage capacity of 200 tons. The ore from the bins passes through a Blake crusher, from this when crushed it goes up an elevator to the top of the building, and as it falls into feed bins there is a Vezin automatic sampler, which distributes a fifth of the sample into a sample bin. The main pulp goes into an ore bin. Besides the crusher the ore can be crushed by rolls and stamps, all of it being wet work. There is also a set of rolls for dry work.

After the ore has passed through a Challenge automatic feeder it passes to coarse rolls, then by elevator to revolving trommel-screens for screen sizing through 10 to 16 to 20 mesh. The trommels are changeable for screening different sized material. What goes through them passes into a hopper directly down to the Wilfley No. 1 tables on the floor below. The oversize goes to regrinding rolls and the tailing of No. 1 also goes back to the regrinder and comes up and goes through a forty-mesh screen.

After passing this the remaining product goes down to a shaking 80-mesh screen. On the upper floor, table No. 2 treats only 80-mesh screenings and finer matter. The more you size the product the better is the work done. One table is run on 20-mesh material, another on 80 and finer, a third on intermediate between 40 and 80. The tailings of the 80 mesh go down to the double decked Wilfley table below and so the ore passes over as many tables as possible. Finally, to avoid even a possibility of loss by escaping slimes, outside the building there are "Cornish-frames," consisting of long narrow wooden troughs lined with canvas. As the slimes pass down over this on a slant, they are treated by a hose which drives off the refuse and causes the fine ore to be caught in the canvas.

The middle floor of the building is mostly occupied by Wilfley tables, crushers, and elevators. On the floor above is a hydraulic classifier which gives two classifications. Any gold remaining in the tailings is thrown into tanks for examination by cyanide.

Stamps.—At the south end of this floor is a full-sized modern stamp battery of five stamps, the stamps weighing 800 pounds and having 97 drops per minute. These stamps crush down to 40 mesh or other desired size. Tailings after plate amalgamation run on to

single deck Wilfley and tailings of that go back over the double deck Wilfley table. A combination can be made of three different sizes on these tables either before or after amalgamation, and finally, if desirable, all the tailings can be treated by cyanide. There is an ingenious device for increasing the percentage of gold that can be caught by amalgamation. A small blower forces a gas generated by mixing ammonia and chloride of lime into the pulp just before it goes into the plate. It keeps the plates bright and in usual large tests has increased the gold saving from 8 to 20% above what had been caught without it.

Coarse material is furnished to jigs, then the jig tailings are reground by stamps or rolls for amalgamation, the tailings after amalgamation passing again to Wilfley tables. Each product of the four tables is kept separate and the working results of each separately noted. There is a Wilfley table on the same floor as the stamp mill and an hydraulic classifier. On the floor above is a Wetherill magnetic separator. This is an upright machine having endless belts working at right angles to one another in connection with a powerful electromagnet. The material or ore falls on the belt and is carried along under the magnet, which picks up whatever has magnetic attraction, the remaining product, carried by one of the belts, drops into a trough and is thus separated. A great range of metals that are not in their natural state magnetic become paramagnetic when roasted, e. g. iron and copper pyrites. As these have different degrees of attraction, the power of the magnet is graded accordingly, and further separation results, thus a certain power would attract roasted iron pyrites and another power roasted copper pyrites, whilst true magnetite is of course readily attracted and abstracted.

Besides these various devices and experimental processes for treating ore, outside at the back of the building are tons upon tons of iron, lead, and zinc slimes from Leadville. These have been treated and a successful separation made of the zinc from the lead and iron. The point made is, that the mill affords an opportunity for making tests on a commercial scale.

Whilst I was there a large consignment of ore came in from Mexico to be tested with a view to putting up a large mill in that country. An assay gives only a very approximate result, as we have said, but an actual test on a large scale at such a mill as this will show what actually will be done day by day at the mill to be erected and whether the erection of such a mill is warranted.

There were consignments of ore from all parts, amongst others we noticed three tons of gravel from the Cape Nome district, Alaska, just arrived, in which we saw the flat schist pebbles, characteristic of that region. This was for examination and testing.

In the basement of the building is a 40 H. P. steam engine, and a dynamo of 125 volts, 16 amperes, with 35 lamp capacity. The building is heated by the Webster steam heating system using the exhaust steam, which is also used in the drying of ores on the ground floor, where exhaust steam is drawn through 20 radiators and dryers. The building being on the level of the Platte River bottom, water is found in abundance just below the surface.

In Mr. Wood's assay office in Denver is a small counterpart of many of the various experimental devices of this larger establishment. These are for experiments on smaller lots of ore.

Denver is a good central location for plants of this kind on account of its numerous mining machinery establishments. Any mine owner after being satisfied with his results can at once order and duplicate any of the machinery required right in the city, which has advantages over a location distant from mines and mining machinery stores.

Much of the money lost in many unfortunate mining enterprises could have been saved and the mines in many cases put on a paying basis had thorough commercial tests been made before building the mills, which later had to shut down because they

were not adapted to the ore they were expected to treat. In these days there is no occasion for such failures, because it is an easy matter to obtain the necessary advice.

Balanced Shaking Screen.

The shaking screen, here illustrated, by reason of its construction, does not require any foundation, framework or bracing other than is needed to support the weight of the screen and resist the pull of the driving belt. The usual destructive shake or vibration common to all ordinary screens is in the case of this screen entirely prevented by a novel and very clever arrangement of the moving parts.

The forward and backward movement of the upper screen is perfectly counterbalanced by the reverse movement of the lower screen, and all of the thrust of the moving parts is completely absorbed in the heavy countershaft. No shake or vibration whatever is communicated to the structure upon which the screen is placed.

The screen frames are so placed on rocker arms that the screening surface always moves through a true arc. At each end of the stroke the material naturally raises slightly and is again forcibly caught by another portion of the screening surface. Great capacity and the most thorough separation is secured on any material whatever that is subject to screening process.

All bearings that require oiling are so far removed from the material that no oil or grease could possibly come in contact with the screened material.

Any material wet or dry that is subject to the process of screening can be rapidly and perfectly separated. Favorable materials such as sand, shale, fire clay, phosphate, cement, and coal, when dry are thoroughly screened at the rate of 15 to 20 tons per hour, and when damp at the rate of 10 to 15 tons per hour.

The dimensions are as follows: Length of upper and lower screens 14 feet; width 3 feet; height over all 26 inches; size of friction pulley 24" x 6"; speed of countershaft 250 R. P. M. Space required for screen complete on skids 18' x 4' 8".

The frame carrying the wire cloth or perforated metal is in removable panels for convenience in renewing the wire cloth and to provide for changes in the fineness of separation.

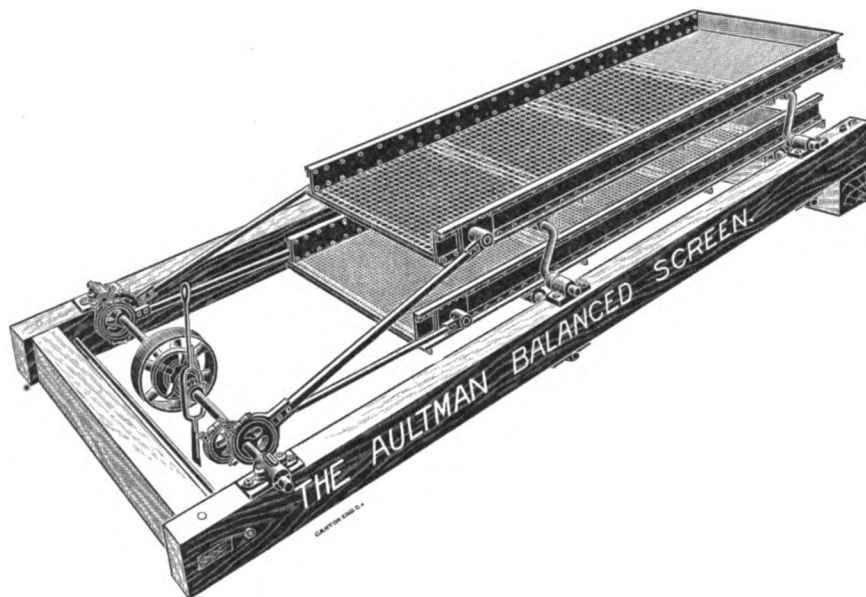
All who have seen the screens and observed their work, have recognized that The Aultman Company has

been successful in removing the objectionable features in shaking screens, also greatly increasing their capacity. They are now prepared to build this screen for the general trade, with either two or four separations, and to guarantee its satisfactory operation. Tests will be made on any material furnished and results submitted for consideration and comparison.

Inquiries are solicited from interested parties and will be given prompt attention. Descriptive catalogues are now ready for distribution.

An Excellent Work on Pumps.

The illustrated catalogue of steam pumps of the A. S. Cameron Steam Pump Works, East 23rd St., New York City deserves more than passing mention, being in reality more of a text book upon pumps than simply a catalogue. The illustrations are wonderfully clear and the directions and explanations very explicit. Each pump is described in detail and accompanying the description is a very complete and useful table, giving complete data for the various sizes of each style of pump made. The back of the book contains very useful data in regard to steam and water, also tables giving the areas of circles advancing by eighths; the pressure of water for different heights for every foot up to 260 feet; the friction loss in pounds pressure per square inch for pipes; capacity of pumps; heights to which pumps will elevate water, etc.



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UNITED STATES COAL STATISTICS.

IN view of the very general interest which is now being taken in the coal resources of the United States and the probably very greatly increased export of coal to European countries, a few facts about the coal fields of the United States will be of general interest.

We are accustomed to hearing that our coal supplies are unlimited, and that our resources in this respect are unbounded, and a great deal of spread eagle talk has been indulged in along this line by those who are ignorant of the true state of the case.

To be sure we have an enormous area underlain by productive coal measures, but all of the coal fields are not equally productive nor do they all produce the highest grade of coal.

The coal areas of the United States are divided by the United States Geological Survey into two principal classes, anthracite and bituminous. Until very recently and still to a great extent, whenever anthracite was spoken of the coal fields of Eastern Pennsylvania were referred to, but it must not be forgotten that Colorado and New Mexico are now supplying a very good grade of anthracite to the Rocky Mountain region, and that small amounts of anthracite have been mined in Virginia for years and also a semi-anthracite in Arkansas, although the output from these latter two sources is always included in the reports of the bituminous product. The detailed division of the coal fields together with the estimated area of each, and the output of each in 1887 and during 1899, are given in the following table taken from Mr. E. W. Parker's report upon The Production of Coal in 1899, which forms a part of the 21st Annual Report of the United States Geological Survey.

An examination of this table shows how very nearly universally coal is distributed throughout the United States, while the production given shows the relative importance of the several sections at the present time. The coal areas as here tabulated would mean very much more if the thickness and quality of coal underlying each area could be stated, but our geological researches have not progressed far enough to allow this to be done as yet with any degree of fullness.

The output of anthracite including Colorado and New Mexico has increased from 39,548,255 short tons in 1887 to 60,514,201 short tons in 1899, or a little more than 50 per cent.

In commenting upon the relative importance of the various fields, as given above, Mr. Parker points out that the Western is the most extensive of the bituminous fields, having an area of nearly 100,000 square miles. In production, however, the fields of the Appalachian system are by far the most important, the yield from these fields, with an area about two-thirds of that of the Western, being over two-thirds of the total bituminous product of the United States. In 1899 the coal product of the Appalachian system was 129,872,259 short tons, an increase of 74,679,225 short tons, or 135.3 per cent. over 1887, and of 15,633,103 short tons, or 13.7 per cent. over 1898. Next in importance is the Central field, having an area of 47,750 square miles, and a production in 1899 of 33,181,247 short tons, about one-fourth of that of the Appalachian, and 17.2 per cent. of the total bituminous product. The Western field is third in producing importance, although first in size. Its product in 1899 was 15,320,393 short tons, about one-eighth of that of the Appalachian field and 8 per cent. of the total. The areas of the coal fields in the Rocky Mountain and Pacific coast fields have not been determined. The former, fourth in producing importance, has increased its output from 3,646,280 short tons in 1887 to 11,949,443 short tons in 1899. The Pacific coast fields produced in 1899, 2,277,741 short tons, 90 per cent. of which was from the state of Washington. The production of these five fields in 1887, 1898, and 1899, with the increases in 1899 as compared with the other two years, is shown in the following table.

From 1889 to 1899 the anthracite product increased $\frac{1}{2}$ and during 1899 the anthracite output exceeded the phenomenal yield of 1895 by 2 $\frac{1}{2}$ million tons.

Mr. Parker says in regard to this production:

The record made in 1899 is an important one. Not only did the production exceed all previous records, but it placed the United States at the head of the coal-producing countries of the world. The production in each of the last three years has been the largest up to that time. In 1897 the output reached for the first time a total of 200,000,000 short tons. The product in 1898 was 219,974,667 short tons, an increase of nearly 10 per cent. over

TABLE GIVING THE ESTIMATED AREA OF THE COAL FIELDS IN THE UNITED STATES AND THE OUTPUT FROM EACH IN 1887 AND IN 1899. (UNITED STATES GEOLOGICAL SURVEY REPORTS.)

	Area.	Product in	
	Sq. Miles.	1887. Short Tons.	1899. Short Tons.
ANTHRACITE.			
New England (Rhode Island and Massachusetts)	500	6,000	
Pennsylvania	480	39,506,255	60,418,005
Colorado and New Mexico	15	86,000	96,196
	995	39,548,255	60,514,201
BITUMINOUS (a.)			
TRIASSIC:			
Virginia	180	30,000	{ 28,853
North Carolina	2,700		
	2,880		
APPALACHIAN:			
Pennsylvania	9,000	81,516,856	74,150,175
Ohio	10,000	10,801,708	16,500,270
Maryland	550	3,278,023	4,807,896
Virginia	2,000	796,263	2,104,334
West Virginia	16,000	4,881,620	19,252,396
Kentucky	11,180	950,903	1,871,560
Tennessee	5,100	1,900,000	3,330,659
Georgia	200	313,715	233,111
Alabama	8,660	1,950,000	7,593,416
	62,690	55,888,088	129,872,259
NORTHERN:			
Michigan	6,700	71,461	624,708
BITUMINOUS (a.)			
CENTRAL:			
Indiana	6,450	3,217,711	6,006,523
Kentucky	4,500	982,282	2,735,705
Illinois	36,800	10,278,890	24,439,019
	47,750	14,478,883	33,181,247
WESTERN:			
Iowa	18,000	4,473,828	5,177,479
Missouri	26,700	3,209,916	3,025,814
Nebraska	3,200	1,500	(c) 20
Kansas	17,000	1,596,879	3,852,267
Arkansas	9,100	129,600	843,554
Indian Territory	20,000	685,911	1,537,427
Texas	4,500	75,000	883,832
	98,500	10,172,634	15,320,393
ROCKY MOUNTAIN, ETC.:			
Dakota		21,470	98,809
Montana		10,202	1,496,451
Idaho		500	
Wyoming		1,170,318	3,887,392
Utah		180,021	786,049
Colorado	2,913	1,755,735	4,718,590
New Mexico		508,034	1,012,152
		3,646,280	11,949,443
BITUMINOUS (a.)			
PACIFIC COAST:			
Washington		772,612	2,029,881
Oregon		31,696	86,888
California		50,000	(c) 160,972
		854,308	2,277,741
Total product sold		124,689,909	
Colliery consumption		5,960,302	
Total product, including colliery consump- tion		130,650,211	253,739,992

(a) Including lignite, brown coal, and scattering lots of anthracite.

(c) Idaho only.

(e) Includes Alaska.

1897. The statistics for 1899 show an increase of 33,765,325 short tons, or 15.35 per cent. over 1898, and of 53,518,327 short tons, or 26.73 per cent. over 1897. Comparing the product in 1899 with some of the earlier years of our history, a still more remarkable advance is shown. In 1889 the total production of coal was 141,229,613 short tons, showing an increase in ten years of 112,510,379 short tons, or nearly 80 per cent. In 1879 our

production amounted to only 66,452,960 short tons, compared with which the output in 1899 shows an increase of about 280 per cent., while in 30 years the production has increased about 700 per cent., the yield in 1899 being eight times that of 1869, one generation ago. In the same period the production of Great Britain has about doubled, that of Germany has been multiplied by 4, and that of France by 2.5. In 1869 the coal product of Great Britain was nearly four times that of the United States, and that of Germany exceeded ours by about 20 per cent.

One of the interesting features of the history of coal production in the United States in the past three years is that the operators were prepared by the preceding years of depression to meet the demands made upon them by the period of prosperity through which the country has been passing. During the four or five years of "hard times" coal operators were contending with

PRODUCTION OF THE FIVE PRINCIPAL BITUMINOUS COAL FIELDS IN 1887, 1898, AND 1899 COMPARED.

Field.	1887.		1898.		1899.	
	Product.	Per Cent. of Total.	Product.	Per Cent. of Total.	Product.	Per Cent. of Total.
	Short Tons.		Short Tons.		Short Tons.	
Appalachian	55,193,034	63.0	114,239,156	68.6	129,872,259	67.2
Central	14,478,883	16.5	25,816,874	15.5	33,181,247	17.2
Western	10,198,034	11.6	13,988,436	8.4	15,320,393	8.0
Rocky Mountain	3,646,280	4.15	10,042,759	6.0	11,949,443	6.2
Pacific Coast	854,308	1.0	2,103,043	1.26	2,277,741	1.18
Increase in 1899 Over 1898.						
	Amount.	Per Cent.	Amount.	Per Cent.		
	Short Tons.		Short Tons.			
Appalachian	15,633,103	18.7	74,679,225	185.3		
Central	7,364,378	28.5	18,702,364	129.2		
Western	1,331,967	9.5	5,127,359	50.3		
Rocky Mountain	1,906,684	19.0	8,308,163	227.7		
Pacific Coast	174,698	8.3	1,423,433	166.6		

steadily declining prices, brought about by a continued overproduction and a keen competition for a market for the output. To meet these conditions, methods were adopted wherever possible for cheapening the cost of production by the installation of coal-cutting machines, mechanical haulage, etc., so that when the extraordinary demands of the past two years developed, many operators were able to expand their production 25 or 50 per cent. without materially increasing the lengths of their pay rolls.

Another feature worthy of note, which is shown in the statistics for 1899, is the advance in the average price per ton and a consequent increase in the value of the product proportionately greater than the increase in product. This is the first time in a period of twelve years when there has been an advance in the general average price. The improvement in the price of coal, however, was not as marked as that shown in many other commodities. Much of the coal marketed in 1899 was sold on contracts made the preceding year, and it was not until the latter part of the year that the operators began to reap actual benefits from the improved conditions.

SECOND-HAND MINING MACHINERY.

MINE owners, manufacturers or dealers, having second-hand mining machinery for sale, will find the Second-Hand Machinery Dept. started in the advertising pages of this issue, the best medium through which to secure purchasers.

Special rates of \$2.00 per inch per insertion have been adopted for second-hand machinery advertisements.

Mr. Carl R. Ickis formerly manager of the Denver Fire Clay Co., died in Denver, Colo., Tuesday, August 7th, 1900, at the age of 31 years.

Book Review.

ANNUAL REPORT OF THE DIRECTOR OF THE MINT, 1899. Washington, D. C.

REPORT OF THE EXECUTIVE COMMITTEE OF THE ANGLO-AMERICAN CLUB OF FREIBERG, SAXONY

BULLETIN OF THE SOCIÉTÉ SCIENTIFIQUE INDUSTRIELLE DE MARSEILLE published at Marseille, France.

ANNUAL REPORTS OF THE TREASURY DEPARTMENT FOR 1899. Production of gold and silver in the United States.

JOURNAL OF THE IRON AND STEEL INSTITUTE, 1900, No. 1, 517 pages edited by Bennet H. Brough, Secretary, 28 Victoria St., London, Eng.

SOME SILVER BEARING VEINS OF MEXICO, pamphlet, 16 pages, by Edward Halse. A paper read before the English Institution of Mining Engineers.

UNITED STATES TREASURY DEPARTMENT, CIRCULAR No. 113, Washington, D. C. Information respecting United States bonds, paper currency, coin, production of precious metals, etc., July, 1900.

JOURNAL OF THE CANADIAN MINING INSTITUTE FOR 1900, edited by the Secretary, B. T. A. Bell, Ottawa, Can. 268 pages, illustrated. The report contains 18 papers and in addition a detailed account of the meeting of the Institute together with the list of members.

JOURNAL OF THE SOCIETY OF ARTS, JULY 20TH TO AUGUST 3RD. This Journal is principally given up to the Cantor lectures which at present are being delivered by Mr. Bennet Brough, the well known English engineer, the subject being the Nature and Field of Metalliferous deposits.

THE CREDIT MAN, a journal published in St. Louis contains the following articles for September: Self Introductory; A Complaint Department for the Credit Men; What Has Been Done by the Credit Men's Associations? Foreign Corporations; Legal Status of Commercial Travelers; Increase of Failures; Three Cases of Special Interest to Bankers; Legal Problems for Credit Men; Legal Miscellany; Credit Men's Directory.

PAPERS READ BEFORE THE INTERNATIONAL CONGRESS OF MINING AND METALLURGY, Paris, France, and published by J. Thomas & Co., 12 Rue Germetet, Saint-Etienne, France.

Coal Mining Machines in the United States, by A. Bachellery; 45 pages.

Explosives in the Coal Mines of Belgium, by Victor Watteyne and Lucien Denoll; 78 pages.

Employment of Safety Explosives in the French Coal Mines, by M. Delafond; 18 pages.

Working Conditions at Great Depth, by M. Joseph Hrabak; 58 pages.

Working Conditions at Great Depth, by Leon Poussiguet; 183 pages.

Working Conditions at Great Depth in Belgium, by M. Simon Stassart; 96 pages.

Composition of the Air in the Mines in the Basin of Donetz, by N. Kotsowsky; 23 pages.

Study of the Ventilation of Preparatory Workings in Coal Mines, by P. Petit; 465 pages.

Employment of Electricity in the Mines, by Joseph Libert; 130 pages.

Electricity and the Mineral Industry, by Wolfgang Wendelin; 49 pages.

Establishment of Underground Magazines, by H. Le Chatelier; 43 pages.

Explanation of the Wetherill Process, by M. Smits; 21 pages.

Mechanical Preparation of Metallic Minerals in Sardaigne, by M. N. Pellati; 9 pages.

Magnetic Separation of Iron Minerals, by M. A. Hermann Wedding; 47 pages.

Aluminum, by M. Heroult; 44 pages.

The Manufacture and Working of Special Steels, by L. Babu; 103 pages.

The Present Condition of the Manufacture of Steel, by M. A. Tissot; 24 pages.

The Present Condition of the Manufacture of Thomas Steel and Its Effects Upon the Puddling Process, by G. Rocour; 17 pages.

Phenomena Which Accompany the Permanent Deformation of Metals, by Le Commandant Hartmann; 79 pages.

Krivoi-Rog and the Present Condition of the Metallurgical Industry in the Middle Russia, by M. Martin Szymanowsky; 77 pages.

Direct Utilization of Blast Furnace Gases for Production of Motive Power, by H. Hubert; 57 pages.

GEOLOGICAL SURVEY OF ALABAMA, BULLETIN No. 6, PRELIMINARY REPORT OF THE CLAYS OF ALABAMA, Eugene A. Smith, State

Geologist, 219 pages not illustrated. This report is the result of the investigations by Dr. Heinrich Ries whose studies have been confined to the northern half of Alabama and to only one or two formations. The report shows that the clay resources of Alabama include every variety ranging from the best of China clays downward. The report is divided into three parts. Part 1 includes a general discussion of clays together with their methods of mining and preparation. Part 2 is a discussion of the geological relations of the clays of Alabama by Dr. Smith. Part 3 is the preliminary report of the physical and chemical properties of the Alabama clays by Dr. Ries. This report is a very interesting addition to the rapidly growing literature of clays. Its typography is not up to the standard which has been set in most of the other states, but this is possibly due to lack of appropriation and to no fault of the author or of the State Geologist.

VOLUME 7, PART 1, GEOLOGICAL SURVEY OF MICHIGAN, Alfred C. Lane, State Geologist. A geological report on Monroe County, by W. H. Sherzer, 17 plates, 3 colored maps, 240 pages. The scope of the book is best shown by the following chapter headings: Geographical and Historical Introduction; Devonian and Quaternary; Silurian Formations Quarries; Physical Geography; The Glacial Epoch in Southeastern Michigan; Soils and Subsoils; Economic Products; Minerals of Monroe County; Fossils of Monroe County. The typographical appearance of the book is excellent and the illustrations, maps, etc., very well shown. Some of the valuable results of Prof. Sherzer's work are the description of the considerable thickness and extent of the Sylvania glass-sand, a work of great value to a state so exceptionally well situated for glass manufacture as Michigan; the description of the deposits of high grade limestone and strontianite, both of which may be important factors in beet-sugar manufacture, while the former is also in great demand for the manufacture of soda ash; and the determination of the limited extent and economic value of the oil and gas. The professional geologist will appreciate the light thrown on the Helderberg question, and on the detailed history of the Great Lakes.

Personals.

The Howe Mfg. Co., has recently been formed with headquarters in Scranton, Pa., to handle the Howe Steam Dryer which rapidly and effectually dries sand and small coal. The officers of this company are President, A. O. Blackington; Vice President, C. W. Tenbroeck; Treasurer and Secretary, A. G. Thomason.

The Kenyon Ventilating & Force Fan Co. has been formed to handle a ventilating fan invented and recently patented by Mr. C. P. Kenyon of Scranton, Pa. The headquarters of this company are 603 Connell Bldg., Scranton Pa., and its officers are as follows: President, Alfred Harvey; Secretary and Treasurer, B. E. Kingsley; Directors, Alfred Harvey, C. D. Sanderson, B. E. Kingsley, R. F. Fox, C. P. Kenyon.

A number of changes have recently been announced by the Pennsylvania Coal Co., affecting both the Coal Co., and the Erie & Wyoming Railroad. Heretofore the mining and breaker departments have been separate, but these have now been combined under a number of district superintendents, each superintendent having direct charge of all the company's interest inside and outside. This new arrangement goes into effect about October 1st and the gentlemen in charge of the several departments will be as follows: George B. Smith, third vice-president; S. Brinckerhoff Thorne, comptroller; Sidney Williams, general superintendent; Andrew Bryden, consulting superintendent of mining; Alexander Bryden, mining engineer. The district superintendents have not yet been named.

Michigan College of Mines.

The purpose of the Michigan College of Mines, located at Houghton, Mich., is to train men to fill positions of usefulness in connection with the development of mining interests and the conduct of mining operations. It aims to train its students not for any particular kind of mining nor for any single operation, but rather to apply the principles of the great basal sciences of mathematics, physics, chemistry, and geology to the specific problems which may happen to confront them in their subsequent work. It endeavors to train not craftsmen but engineers. The College embraces departments of Mathematics and Physics, Chemistry and Metallurgy, Geology and Mineralogy, Mechanical and Electrical Engineering and Civil and Mining Engineering. It is obvious that mining engineering is a very broad field covering a wide extent of knowledge and methods. The range is so wide that no student can hope to cover thoroughly all of its departments in the ordinary college course. It was to meet these conditions that the elective system was put into operation, so that while a student is required to take the fundamental work necessary for all engineering, he is permitted to devote the greater part of his time to the lines for which he is best adapted.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The editor is not responsible for views expressed by correspondents in this Department.

Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Relative Values of Products of Mining and Agriculture.

Editor Mines and Minerals:

SIR:—The articles which appear in MINES AND MINERALS are always of a high standard of excellence, combining the great qualities accuracy, clearness, minuteness of detail with that of being interesting. As I am continually on the move I find the Bound Volumes of MINES AND MINERALS too large and heavy to pack around, so I cut out all the articles which are of especial interest to me, number and index them and put them with other useful mining information and have them bound together, thus obtaining a handy reference book on a large variety of mining subjects, all in a nutshell so to speak.

I have always taken much interest in your paper and have noticed that you go a long way out of your way to oblige your subscribers with information, and I would like to ask, what was the value in the United States for any recent year of the total product gained by mining in comparison with that gained by farming (including stock raising), the products not to include manufactured stuff. I think the figures of the oil industry ought to go separate from mining proper. The same figures of Great Britain's product would also be interesting.

Yours truly,

Nelson, B. C.

A. P. BLANDY.

The value of the mineral production in the United States during 1899 has not yet been finally reported by the government in Washington, but advance reports indicate that it will be about \$1,000,000,000.

The advance bulletins of the Department of Agriculture give the following as the value of the farm products:

Buckwheat	6,183,675		
Oats	198,167,975		
Barley	29,594,254		
Hay	411,926,187		
Wheat	319,145,259	Milk Cows	514,812,106
Corn	629,210,110	Sheep	122,665,918
Rye	12,214,118	Horses	603,969,442
White Potatoes	89,328,832	Mules	111,717,092
Total	1,696,579,410	Other Cattle	689,486,250
			2,042,650,813

Miscellaneous Queries.

Editor Mines and Minerals:

SIR:—(1) What quantity of water per hour will be discharged by a pump 14 inches diameter, 30 inches stroke, running at a speed of 90 feet per minute? (2) An isolated coal field contains 100 acres, the seam is $4\frac{1}{2}$ feet thick, the specific gravity of the coal is 1.3; Assuming that 95 per cent. of the coal is recovered, how many short tons of coal will be produced from this coal field? (3) In what respect does the atmospheric pressure affect a siphon or a pump? (4) Where is the proper place to take a reading of the water gauge in a mine airway, and what precautions are necessary to procure a correct reading of the same? (5) In opening up a new coal field what conditions would determine the method of working the seam, whether the pillar-and-stall, or longwall, or room-and-chamber method should be used? (6) Give in brief your ideas in relation to the location and ventilation of mine stables.

Yours truly,

SUBSCRIBER.

1. The number of gallons of water (G) discharged per hour by a pump 14 inches diameter, 30 inches stroke, running at a speed of 90 feet per minute may be calculated by the formula,

$$G = 1.96 S d^2 = 1.96 \times 90 \times 14^2 = 34,574 \text{ gal. per hr.}$$

2. In a coal field containing 100 acres, 95 per cent. of the coal being recovered, we estimate upon 95 acres instead of 100. The weight of the coal in short tons (1 ton = 2,000 pounds) produced will then be,

$$W = \frac{43,560 \times 95 \times 4\frac{1}{2} \times 62.5 \times 1.3}{2,000} = 756,500 \text{ tons.}$$

An acre = 43,560 sq. ft.; 1 cubic foot of water = 62.5 lb.

3. The pressure of the atmosphere determines the vertical height a pump or a siphon will draw, since it is the pressure of the atmosphere that forces the water up the suction pipe. If we

denote the pressure of the atmosphere, in pounds per square inch, by p , we have for the theoretical height (H) the pump or siphon will draw, $H = \frac{p}{.434}$. The actual height in practice would be

about two-thirds of the theoretical height. (See article "Pressure—How Measured," page 331 of the February, 1900, issue of MINES AND MINERALS.)

4. A water-gauge reading should be taken at any air-tight door or brattice between the main intake and return airways, at a point close to the foot of the downcast shaft, or at the mouth of any split which it is desired to measure. The precautions necessary to be observed are that the door or brattice be air-tight; that the mouth of the gauge be protected from the direct force of the air current; that the gauge be vertical, and its reading carefully taken. (See answer to Ques. 30, 1900, page 273 of the January issue of MINES AND MINERALS.)

5. The conditions which determine the method to be employed in working any given coal field are briefly as follows: (a) Depth of the seam below the surface; (b) character of the strata forming the roof or floor of the coal seam; (c) character of the coal; (d) inclination and thickness of the seam; (e) presence of gas in the coal or in contiguous strata. (See article "Systems of Working Coal," pages 245 and 292 of the January and February issues of MINES AND MINERALS, 1899.)

6. Mine stables should be located at a point as convenient to the working face as possible, but where the mules can be rescued quickly in case of accident. The stables should be ventilated by a fresh-air split, which should be returned directly to the upcast; they should be well drained, and furnished with a good supply of pure water. The location of the stables should be such as to permit of easy access at all times, to remove refuse and supply the daily feed, etc. (See answer to Ques. 562, page 409 of the April, 1900, issue of MINES AND MINERALS.)

Arizona Notes.

Editor Mines and Minerals:

SIR:—In my last letter I partially promised something of especial interest to machinery men and also something of interest to investors in mining property. Things are shaping up nicely in this section for two or three good plants in the near future in the line of concentration, and cyanide plants. New discoveries, and good ore bodies being opened up nearly every week. We have not the railroads here that you have in the East. Two trunk lines east and west and one north and south with some small branches built and owned by mining companies constitute our transportation facilities. But men familiar with mining are not deterred by that, as is proven by the Rosborough copper property, about 90 miles from a railroad. Colorado people who know a good thing when they see it have fastened it, shipped in a hoist and are going at it in Colorado style. Business is their motto, and developments will result in this case in a mine. On Wallajai Mountain, Chas. Metcalfe and partner have a very promising group of claims. The Great Eastern claim on which the principal work is being done, is an immense ledge of what is termed low grade ore and is a fine concentrating proposition. The group has been just incorporated under the name of the Great Eastern Mining Co. Our warm weather is about passed and another month will see a general move in mining all over this country. The new smelter at Needles on the California side of the Colorado river will shortly blow in, and that will give a good many of the miners that can't stand transportation charges on a long haul a chance to have their ore treated. The inquiries for mining property are on the increase and come from all directions, and are indications of the interest that is being manifested in the business. I look for considerable activity during the balance of 1900.

In the last few years great strides have been made in perfecting mining machinery, and especially machines for the saving of precious minerals; but the writer has lately seen an ore concentrator which appears to have reached nearer perfection in the saving of values than any other concentrator ever before seen by him. The machine spoken of is the New Standard Concentrator made by the New Standard Concentrator Company, of Los Angeles, Cal.

In designing this machine the inventor has used the well-known bump principle to produce the separation, but has added new features and new principles, which have so perfected this class of machines that he has really established a "new standard" in the treatment of concentrating ores. He has provided means for imparting to the table a most perfect settling and separating motion, and at the same time he has given to the table the greatest possible range of adjustment to suit the different classes of ores. Very little power is required to operate this machine—about one-fourth horsepower, which is surprisingly little when the quantity of material treated is taken into consideration. The

amount of material treated per 24 hours will range from 15 to 30 tons, depending upon the percentage of heavy minerals in the ore.

One of the important features of the machine is the perfect separating surface of the table. This surface, while allowing of the rapid working of the ores, and rapid discharge of gangue, prevents the loss of any mineral by settling it below the action of the strong water currents until it is brought to the point of final cleaning. I have seen cleaner work and higher savings made on this machine than any concentrator I ever saw before, and it is only a question of a short time before this machine will supersede other ore concentrators on the market, as the mine owner of the present day must increase his profits by saving values from the gangue or tailings, which have hitherto been allowed to run away into the tailing pond.

Signal, Arizona, Sept. 3, 1900.

W. A. MENSCH.

Mensuration.

Editor Mines and Minerals:

SIR:—The following is an answer to Mr. I. C. Harrington's mensuration problem in the September issue of MINES AND MINERALS:

If a board is 12 ft. long and 12 inches wide at the big end and tapers from both sides to a point, I would like to know where it should be sawed across so as to have an equal amount of timber in each end.

Let x = the distance from the pointed end to the point at which the board should be sawed.

The area of the board = $\frac{12}{2}$ sq. ft. = 6 ft.

The area of half the board = 3 sq. ft.

The length of the saw cut = $\frac{x}{12}$.

and the area of the triangular portion = $\frac{x \times x}{2 \times 12} = \frac{x^2}{24}$

$\therefore \frac{x^2}{24} = 3$ and $x^2 = 72$.

$\therefore x = 6\sqrt{2} = 8.49$ feet.

Therefore the board would have to be sawed 8.49 feet from the pointed end.

Yours, etc.,

3 Kelso Road, Leeds, England.

J. E. TIFFANY, B. Sc.

Let x = length of the cut, y the distance from the base to the cut.

Superficial area whole board = 6 square feet. Whole area = $6 = y + xy = y(1+x)$, or $y = \frac{6}{1+x}$. (1)

By proportion $12 - \frac{x}{y} = \frac{1}{12}$ or $12x = 12 - y$
or $y = 12 - 12x = 12(1-x)$. (2)

Substitute value of y in (1) we have $12(1-x) = \frac{6}{1+x}$ or $1 - x^2 = .5$;
or $x^2 = .5$.

$\therefore x = .7071$ ft. or practically $8\frac{1}{8}$ inches, and

$y = \frac{6}{1.7071} = 3.515$ or 3 ft. $6\frac{1}{8}$ inches.

$\therefore$ Saw the board 8 ft. $5\frac{1}{8}$ inches from the point A.

Yours, etc.,

Salt Lake City, U.

H. S. J.

Centrifugal Ventilators.

Editor Mines and Minerals:

SIR:—Mr. Markmann under the heading "Centrifugal Ventilators," in the Correspondence Columns of your August issue, further criticised my article upon the designing of these machines. Having shown that in any circulation the work of compression due to the action of the ventilating pressure is identical with the effective work Qp performed by the motor in maintaining circulation, he objects to our deductions therefrom; viz., that this identity serves to verify our results. In formula 2 we equated Qp with the work expressed in terms of the motor (formula 1), and are hence justified in looking for equivalent results in formulas 1 and 3. However, the writer's original statement in this regard (page 55, MINES AND MINERALS, September, 1899) referred to the lack of identity between formula 1 expressing the work of the motor in terms of the motor, and formula 3 expressing the work of compression. It is these expressions of work that though giving equivalent results through all the various changes of volume and pressure, are still unidentical; and it is through the equivalency of these results that we have claimed that the latter verifies the former.

In another paragraph the writer of the criticism admits that the compressive formula may be written $Q_1 p_1 \log \text{nat } \frac{p_1}{p_0}$, in place

of $Q_0 p_0 \log \text{nat } \frac{p_1}{p_0}$, but claims it is the latter that reduces to the form $u_c = Qp$, whereas either of these forms will reduce to the same general equation expressing the work of compression as being approximately equal to Qp , since $\frac{p_1}{p_0}$ under the hypothesis becomes approximately equal to 1, giving finally $u_c = Qp$ approximately.

In the next paragraph the obviously erroneous statement is made that "The force applied to the resistance must be proportioned to the latter." Why? For the same velocity or time, this would be correct. Two men will raise double the load raised by one man, in the same time; but we may employ ten men or twenty men or any force at hand to raise the same load. Most certainly the centrifugal force developed in the fan is not proportional to the resistance, for as the mine resistance is increased in development, the quantity of air in circulation is decreased at the same speed of the fan developing the same centrifugal force. Such a statement is careless in the extreme, and this error renders void the statement, in the same paragraph, that the

centrifugal force $\frac{W V_p^2}{g - \rho}$ being proportional to V_p^2 (velocity of the center of gravity of one compartment of the fan), or n^2 (speed of rotation of the fan), Q is therefore proportional to n . The relation of the speed of rotation n to the quantity or yield Q is not to be determined in so simple a manner, but must be referred to the basis of work performed.

The next point considered is our method of obtaining the expression for the work of the fan *per unit of time*, and the statement is made that we have in all of our papers up to date used

the expression $U = mf \times \frac{f}{2}$ for "the work of the constant force mf for each second." As a matter of fact we have always based our calculations upon the work the fan will perform in a minute, instead of a second of time, finding the former unit more convenient than the latter, since the circulation is given in cubic feet per minute. But emphasis is laid upon the fact that we have called this the work of acceleration for each unit of time, and attention is drawn to the fact that work of acceleration is different for every unit of time, and that the expression referred to above expresses the work for the first second of acceleration only, which is true. But refer to our hypothesis that the work of the fan is a work performed upon a fixed quantity of air Q , (cubic feet per minute); such quantity of air being brought from a state of rest to a state of motion. The limiting conditions are rest and motion; the work is regularly performed upon a quantity of air Q , and is accomplished in exactly a unit of time. Under this hypothesis we are not concerned with what the work would be in the next minute, or in any succeeding minute, the expression for this work of acceleration being complete in the first second. Under this hypothesis it is a uniform work performed each minute upon a fixed quantity of air. The question might properly be asked, "Is the acceleration f the same as the velocity v , in the airway?" Certainly not. It would be were the centrifugal

force F equal to the resistance $\frac{pa}{K}$, but it is an unwarranted assumption to make it so. The force applied to move a mass is not necessarily equal to the mass. The force applied to the end of a lever may be greater or less than the weight it moves, and only when the distances through which the respective movements take place are equal can the force be equal to the resistance. In the same way the acceleration f due to the centrifugal force F is only equal to v when the force F is equal to the total resistance $\frac{pa}{K}$. We refer to this again below.

The first velocity v in this case is zero, in the expression found in Ganot's "Elements de Physique" $U = \frac{1}{2} m (v_1^2 - v^2)$,

which becomes $U = \frac{1}{2} m v_1^2$, and we were right in saying "The change of the square of the velocity for a unit of time would be the square of the acceleration," in this case. The words in which Dr. Atkinson, in his translation of Ganot, paraphrases this formula are correct in our humble opinion. "The change of the square of the velocity" can only mean the difference of the squares of the velocities.

The statement that $\frac{pa}{K}$ is not the resistance does not prove anything. If pa is the effective or mine resistance and K the coefficient of efficiency of the motor, we fail to see why $\frac{pa}{K}$ is not the correct expression for the total resistance, or the resistance of the mine and the motor together.

To what does the term efficiency refer in this case? Mr. Markmann compares the efficiency given in our example ($K = .8392$) with other published efficiencies of ventilating motors, stating that they rarely exceed 70%. The term efficiency is a broad term. In the usual sense in which it is used in reference to fans, it refers to the percentage of the work shown by the engine card that becomes effective upon the air in the airway. The engine card work includes not only the work absorbed in running the engine, but also that of revolving the fan. The writer has frequently drawn attention to the fact that both of these works should be eliminated in estimating efficiency as in this formula. The question is, What percentage of theoretical power does this or that type of construction make effective? In this calculation allowance might preferably be made for the mechanical revolution of the fan, but never for that of the engine, as the latter is not a part of the fan. To make this clear we will refer to a test of a Capell fan, made at Scalp Level, Pa., as recorded on page 318, MINES AND MINERALS, February, 1898, in which an efficiency of 71% is shown at a speed of 200 revolutions per minute. The indicated horsepower of the engine was 204 h. p. Thurston in his Manual of the Steam Engine, page 556, Vol. I, states that the percentage of the power of an engine running under full load that is absorbed by itself varies from 5 to 10 per cent., according to the state of lubrication, etc. This latter is never too good in the case of a fan engine, and we are safe in assuming that of the 204 horsepower, in the Scalp Level test, 20 horsepower was consumed in running the engine and perhaps 16 in running the fan, exclusive of the air, leaving 168 as the actual indicated horsepower applied to the generation of an air current. The horsepower of this current as measured in the fan drift was 145 h. p., thus showing an efficiency, on a formula basis, of 86.3 per cent.

The assertion that "The work of the fan is not a work of acceleration, because it is work against resistance" will not find a shadow of support in the established laws of mechanics. Referring to the illustrations of a ship sailing or a train moving at a uniform speed, quoted from Ganot, where they are used as illustrations of force producing uniform motion against resistance, we would ask, Is there anything in the quotation that supports the deductions drawn from them? Was there no resistance present when the ship or train was starting from rest, and attaining a uniform velocity? The quotation speaks of the force as producing a uniform velocity against resistance, but does not even vaguely hint that acceleration cannot take place against resistance. The study of Attwood's gravity machine will help to answer the question whether or not acceleration takes place against resistance, (page 522 MINES AND MINERALS, June, 1900). In the Attwood machine two equal weights are suspended from the opposite ends of a cord that passes over a frictionless pulley. An additional weight representing the accelerating force is now added to one of the equal weights, and imparts motion to the entire system. This is an illustration of acceleration against resistance, and furnishes an interesting study. For example, if the additional weight were allowed to drop freely under the influence of gravity, its acceleration would be g , but when resisted by the other weights and imparting motion to a mass greater than itself, the acceleration is no longer g but f . In the one case the accelerating force is equal to the weight of the body accelerated, in the other case it is not; but always the ratio of the accelerations is equal to the ratio of the masses accelerated. For example, the acceleration due to gravity is g , that due to the force F is f . Gravity acting upon a mass m produces the force W which we call weight; and always $\frac{F}{W} = \frac{f}{g}$. And since $W = mg$, $F = mf$. Only when $F = W$ does $f = g$. This is the case when a body falls freely under the influence of gravity, or a mass is moved by a force equal to its own weight. But when the accelerating force is not equal to the weight of the mass accelerated, the acceleration must be calculated as above. This little study teaches that *Acceleration against resistance bears the same ratio to the acceleration of a falling body (in vacuo) as the moving force bears to the resistance.* Applying this to our present case, the accelerating force is the centrifugal force F developed in the fan. The total pressure or resistance $\frac{pa}{K}$ represents the weight of the entire mass accelerated.

The work performed by the motor is the work performed each minute of time, in bringing a fixed quantity of air (cubic feet per minute) from a state of rest in the atmosphere to a uniform velocity in the airway. The acceleration f is not v . The former is a function of the centrifugal force developed in the fan, while the latter is a function of the resistance to the circulation. The work of the centrifugal force, however, is equal to the work of the resistances; and we write

$$60 F \frac{f}{2} = Q p.$$

Yours truly,
J. T. BEARD.

Scranton, Pa., August 11, 1900.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for October.

QUES. 620.—*Principle of the Safety Lamp.*—Explain clearly and simply the principle of the safety lamp, or tell in a few plain words what prevents the flame of the gases burning within the lamp from passing through the apertures of the wire gauze.

QUES. 621.—*Measurement of Water Flowing in a Ditch or Flume.* The weir opening of a certain flume is exactly 72 inches in width, and the depth of water flowing over the weir is 5½ inches. Calculate the number of gallons of water flowing over the weir per minute. Desiring to check the measurement of the flow in this flume, a little piece of board was floated upon the surface of the water in the flume, and the time observed that it took to pass between two points 50 feet apart. The observed time was 36 seconds. The full width of the flume in the clear is 80 inches, and the depth of the water 8 inches. Show how closely this latter observation checks the first calculation.

QUES. 622.—*Size of Pump.*—Calculate the size of a direct acting pump that will discharge 1,600 gallons of water per minute from a sump at the bottom of a shaft 300 feet deep, assuming the steam cylinder pressure to be 80 pounds per square inch.

QUES. 623.—*Force Required to Open a Mine Door.*—Calculate the force required to pull open a mine door at the shaft bottom, between the main intake and return entries of a mine, the water-gauge reading at the door being 3 inches. The size of the door is 5 ft. × 6 ft., and the position of the handle is 5½ feet from the axis of the hinges. The door is assumed to fit snugly and to be practically air-tight.

QUES. 624.—*Mine Resistance, How Affected by Splitting.*—When the air current passing in a mine is divided into two or more equal splits, is the resistance of the mine thereby diminished or increased, or does it remain the same after the splitting as before, assuming the power upon the air is constant?

QUES. 625.—*To Determine the Dip of a Seam by Means of Three Bore Holes.*—In order to determine the amount and the direction of the dip of a certain coal seam, three holes were sunk to the seam as follows: Hole A is N 49° 20' E, 1,500 yards from hole B; and hole B is S 5° 50' E, 230 yards from hole C. The surface elevations above datum, and the depth of the holes are respectively as follows: A, elevation 980 ft., depth 300 ft., B, elevation 650 ft., depth 270 ft., C, elevation 1,090 ft., depth 740 ft. Determine the depth of a shaft located at a point 400 ft. S 15° W of hole A, where the surface elevation is 710 ft.; also determine the course or bearing of a slant road in this seam having a grade of 1 in 10, dipping in a southerly direction.

QUES. 626.—*Acceleration Against Resistance.*—Can acceleration take place against resistance, and if so, how is acceleration to be determined? Does the tractive force of an engine accelerate the motion of a train until a uniform grade is attained, and why does it not continue to accelerate always, or what is the limit to the acceleration in such a case?

QUES. 627.—*Arrangement of Shaft Bottom.*—Describe the arrangement of the tracks, manway, pumps, etc., at the bottom of a shaft 250 feet deep, and making 1,200 gallons per hour, the output of the shaft being 1,000 tons per day of 10 hours and all of the pumping to be done in four hours, or between shifts, morning and evening. Give the size of pump, size of shaft, and depth of sump, and length and grade of shaft bottom. Caging is to be done from both sides of the shaft, and arrangements must be made for cross-caging in case of unequal production.

Answers to Questions Which Appeared in the August and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 586.—The air in a certain mine is traveling in two splits, as follows: Split A, which is 6 ft. $\times$ 8 ft. and 10,000 feet long, is passing 40,000 cubic feet of air per minute, split B, which is 8 ft. $\times$ 12 ft. and 14,000 feet long, is passing 80,000 cubic feet per minute. We cannot increase the power of the ventilator; but we desire more air in split B, especially. Splits A and B start from the bottom of the downcast shaft. The shafts are each shallow and have a large area, so that their resistances may be ignored. We find, after careful consideration, that it is possible to again split the air traveling in B, at a point 2,000 feet inbye from the foot of the downcast, thereby forming two secondary splits as follows: Split c, 8 ft. $\times$ 12 ft., 4,000 feet long; split d, 8 ft. $\times$ 12 ft., 6,000 feet long; while split B would, then, be 8 ft. $\times$ 12 ft., and 4,000 feet long, including its return. Before making this change, however, we would like to be able to tell exactly what benefit would be derived by so doing; since some work is necessary in the way of erection of doors, overcasts, etc., which entails expense. With the same power of ventilator, can you tell me what quantity of air will pass in each split without the use of any regulators?

ANS.—Let us, first of all, find the amount of work the ventilator must perform to pass 40,000 cubic feet of air per minute through split A, and 80,000 cubic feet through split B. The pressure is $p = \frac{.00000001 \times 280,000 \times 833\frac{1}{3}}{48} = 40.51$ lb. per sq. ft. Then, as the pressure per square foot is the same for both splits, the total work is $U = p q = (40,000 + 80,000) \times 40.51 = 4,861,125$ foot-pounds.

Let v_1, a_1, s_1, p_1 , etc., v_2, a_2, s_2, p_2 , etc., v_3, a_3, s_3, p_3 , etc., v_4, a_4, s_4, p_4 , etc., represent the velocity, sectional area, rubbing surface, pressure per square foot, etc., for A, B, c and d splits respectively.

Then,
 $a_1 = 6 \times 8 = 48$ sq. ft., and $s_1 = 2(6 + 8) \times 10,000 = 280,000$ sq. ft.
 $a_2 = 8 \times 12 = 96$ sq. ft., and $s_2 = 2(8 + 12) \times 4,000 = 160,000$ sq. ft.
 $a_3 = 8 \times 12 = 96$ sq. ft., and $s_3 = 2(8 + 12) \times 4,000 = 160,000$ sq. ft.
 $a_4 = 8 \times 12 = 96$ sq. ft., and $s_4 = 2(8 + 12) \times 6,000 = 240,000$ sq. ft.

Now, $p = \frac{k s v^2}{a}$, but $p_1 = p_2 + p_3$; hence, $\frac{k s_1 v_1^2}{a_1} = \frac{k s_2 v_2^2}{a_2} + \frac{k s_3 v_3^2}{a_3}$, or $\frac{s_1 v_1^2}{a_1} = \frac{s_2 v_2^2}{a_2} + \frac{s_3 v_3^2}{a_3}$, and substituting known values, we have, $\frac{28 v_1^2}{48} = \frac{16 v_2^2}{96} + \frac{16 v_3^2}{96}$, or by reduction $3.5 v_1^2 = v_2^2 + v_3^2$.

Now, since the areas are equal, in this case, $v_2 = v_3 + v_4$. But, v_3 and v_4 vary inversely as the square roots of the lengths of the airways, which are as 4:6. Hence, the relative velocities in these splits are as follows: $v_3 = \sqrt{6} = 2.4495$ ft.; $v_4 = \sqrt{4} = 2$ ft. and $v_2 = 2.4495 + 2 = 4.4495$ ft. per min. Then $3.5 v_1^2 = 4.4495^2 + 6 = 25.798$; and $v_1 = \sqrt{\frac{25.798}{3.5}} = 2.715$.

The power for each split is proportional to $s v^2$. Hence, the relative work absorbed by each split is as follows:

$$\begin{aligned} s_1 v_1^2 &= 28 \times 2.715^2 = 560,362 \text{ ft. lb.} \\ s_2 v_2^2 &= 16 \times 4.4495^2 = 1,409,452 \text{ ft. lb.} \\ s_3 v_3^2 &= 16 \times 2.4495^2 = 235,158 \text{ ft. lb.} \\ s_4 v_4^2 &= 24 \times 2^2 = 192,000 \text{ ft. lb.} \end{aligned}$$

Total relative work, 2,396,972 ft. lb.

We found, above, that the work performed by the ventilator is equal to 4,861,125 foot-pounds. Hence, the ratio of work is $\frac{4,861,125}{2,396,972} = 2.028$; and we have for the actual work absorbed in each respective split, as follows:

$$\begin{aligned} u_1 &= 2,028 \times 560,362 = 1,136,421 \text{ ft. lb.} \\ u_2 &= 2,028 \times 1,409,452 = 2,858,400 \text{ ft. lb.} \\ u_3 &= 2,028 \times 235,158 = 476,900 \text{ ft. lb.} \\ u_4 &= 2,028 \times 192 = 389,375 \text{ ft. lb.} \end{aligned}$$

Finally, $q = a \sqrt{\frac{u}{k s}}$; hence, we have for the quantity of air that will circulate in each split

$$q_1 = 48 \sqrt{\frac{1,136,421}{.00000001 \times 280,000}} = 35,539 \text{ cu. ft.}$$

$$q_2 = 96 \sqrt{\frac{2,858,400}{.00000001 \times 160,000}} = 116,484 \text{ cu. ft.}$$

$$q_3 = 96 \sqrt{\frac{476,898}{.00000001 \times 160,000}} = 64,127 \text{ cu. ft.}$$

$$q_4 = 96 \sqrt{\frac{389,384}{.00000001 \times 240,000}} = 52,359 \text{ cu. ft.}$$

Very truly yours,

ADOLPHE COOK, Cokeville, Pa.

[Owing to the importance of this question as a practical problem in the ventilation of mines; and on account of the difference in the methods of solution, we give below the answer which merits the second prize. Other answers were received making use of the term *moment of resistance*. They were, however, not as clear and reasonable.]

Second Prize.—

ANS.—Assuming a velocity of 1 in split B, the pressure will be found from the equation $p = \frac{k s v^2}{a}$ and taking .00000001 as the coefficient we have for forcing 96 cubic feet of air through split B, and its return a pressure $p = \frac{.00000001 \times 160,000 \times 1^2}{96} = .00001667$ pounds. The quantities in splits c and d will be inversely proportional to the square roots of their lengths, and eliminating the ciphers, we have for the relative quantity of air that will circulate in split c, $\frac{\sqrt{6} \times 96}{\sqrt{4} + \sqrt{6}} = 52.85$ cu. ft. The pressures for splits c and d being equal we need only find the pressure for c and it is $p = \frac{.00000001 \times 160,000 \times (52.85)^2}{96} = .0000505$ pound. This makes the pressure (p) for split B to circulate 96 cubic feet of air .00001667 + .0000505 = .00002172 pound. As we will have the same pressure for split A, the relative quantity of air in split A is found from the expression

$\sqrt{\frac{p a}{k s}} \times a$; and substituting values, we have, $\sqrt{\frac{.00002172 \times 48}{.00000001 \times 280,000}} \times 48 = 29.29$ cu. ft. This makes the total relative quantity $96 + 29.29 = 125.29$ cubic feet of air circulating in the mine under a pressure of .00002172 pound. The expression for the work performed is $u = q p$, and the work performed in circulating this quantity is therefore $125.29 \times .00002172 = .00272125$ foot-pounds.

The original pressure (p) required to circulate the given quantity is found from the expression $p = \frac{k s v^2}{a}$ and substituting the given values we have, $p = \frac{.00000001 \times 280,000 \times (4.4495)^2}{48} = 40.51$ pounds. For the available units of work we have $u = (80,000 + 40,000) \times 40.51 = 4,861,200$ foot-pounds. The quantity that will circulate in the mine after the splits are made, and with no regulators in use is therefore $\frac{4,861,200 \times 125.29}{.00272125} = 152,021 + \text{cu. ft.}$

The quantities that will now pass through splits A, B, c and d respectively is found as follows: for

$$\text{Split A} = \frac{29.29}{125.29} \times 152,021 = 35,539 \text{ cu. ft.}$$

$$\text{Split B} = 152,021 - 35,539 = 116,482 \text{ cu. ft.}$$

$$\text{Split c} = \frac{52.85}{96} \times 116,482 = 64,127 \text{ cu. ft.}$$

$$\text{Split d} = 116,482 - 64,127 = 52,355 \text{ cu. ft.}$$

Proof. $u = q p$ and taking the values for split A, velocity $= \frac{35,539}{48} = 740.4$ ft. per min. Then,

$$p = \frac{.00000001 \times 280,000 \times 740.4^2}{48} = 31.978 \text{ lb.}$$

and the units of work $u = 152,021 \times 31.978 = 4,861,200$ ft. lb.

JAMES RADFORD, Springfield, Ill.

[Another method of solution of the above example is the method by the *potential* which is simple and shorter than either of the two preceding methods. In splitting air-currents it is customary to consider the pressure per square foot or *unit pressure* (p) as the same for all the splits; its expression being $p = \frac{k s}{a^3} q^2$. It is evident, k being constant, q varies directly as the expression $a \sqrt{\frac{p}{k s}}$ which we call the *pressure potential*; and writing X_p for this

potential, we have for the pressure producing circulation in any split or airway, $p = \frac{q^2}{X_p} \times k$.

Solution.—First find the pressure potential for each split indicating the several splits by the subscript letters 1, 2, 3, 4; thus for

$$\text{split } A, X_1 = 48 \sqrt{\frac{48}{2(6+8) \times 10,000}} = .6285;$$

$$\text{split } B, X_2 = 96 \sqrt{\frac{96}{2(8+12) \times 4,000}} = 2.3515;$$

$$\text{split } c, X_3 = 96 \sqrt{\frac{96}{2(8+12) \times 4,000}} = 2.3515;$$

$$\text{split } d, X_4 = 96 \sqrt{\frac{96}{2(8+12) \times 6,000}} = 1.9200.$$

For constant pressure, or for all splits starting from the same point, as for example splits c and d , we have

$$\text{or, } \frac{q_3}{X_3} = \frac{q_4}{X_4} \therefore X_3 : X_4 :: q_3 : q_4.$$

Whence, $\frac{q_3}{X_3} = \frac{(q_3 + q_4)}{(X_3 + X_4)}$, and in general, indicating the sum of all the quantities in any number of splits starting from one point by Σ , we have, $\frac{q}{X_p} = \frac{\Sigma q}{\Sigma X_p}$. And always the pressure due to the splits is the square of this ratio, multiplied by the coefficient k , or $p = \left(\frac{\Sigma q}{\Sigma X_p}\right)^2 \times k$. From what precedes, we write for the relative pressures, remembering that $q_3 = q_3 + q_4$.

$$\text{Split } A, p_1 = \left(\frac{q_1}{X_1}\right)^2 = \frac{q_1^2}{.6285^2} = 2.532 q_1^2;$$

$$\text{split } B, p_2 = \left(\frac{q_2}{X_2}\right)^2 = \frac{q_2^2}{2.3515^2} = .1808 q_2^2;$$

$$\text{splits } c \text{ and } d, p_3 = \left(\frac{q_3}{X_3 + X_4}\right)^2 = \frac{q_3^2}{4.2715^2} = .0548 q_3^2.$$

$$\text{But } p_1 = p_2 + p_3 \text{ which gives the equation } 2.532 q_1^2 = (.1808 + .0548) q_2^2,$$

or,

$$q_2 = 3.2781 q_1,$$

and calling

$$Q = q_1 + q_2, \text{ we have}$$

$$Q = 4.2781 q_1,$$

or,

$$q_1 = .2338 Q.$$

Now since the power cannot be increased, the units of work Qp is the same before and after the change; hence,

$$120,000 \left(\frac{40,000}{X_1}\right)^2 = Q \left(\frac{q_1}{X_1}\right)^2$$

and writing for q_1 its value $.2338Q$, we have after reducing,

$$Q = \sqrt{\frac{120,000 \times 40,000^2}{.2338^2}} = 152,029 \text{ cu. ft.}$$

as the total quantity of air in circulation. Then the quantity circulating in each split is as follows:

$$\text{Split } A, q_1 = .2338 \times 152,029 = 35,539 \text{ cu. ft.};$$

$$\text{split } B, q_2 = 152,029 - 35,539 = 116,490 \text{ cu. ft.};$$

$$\text{split } c, q_3 = \frac{2.3515}{4.2715} \times 116,490 = 64,130 \text{ cu. ft.};$$

$$\text{split } d, q_4 = \frac{1.92}{4.2715} \times 116,490 = 52,360 \text{ cu. ft.}$$

—EDITOR.]

QUES. 604.—Preservation of Mine Timber.—What is the action of creosote in the preservation of mine timber? Describe also the manner in which timber is preserved by charring.

Ans.—The action of creosote upon wood may be described as follows:

(1) *A chemical action.*—It is a fact that acids are not truly antiseptic but they possess to a greater or less degree the power of coagulating albumen. It is this property that does more to preserve the timber than anything else. The tarry acid having effected the coagulation of the albumen of the wood sap, this coagulated albumen mixes with the naphthalene of the creosote which as soon as the temperature becomes sufficiently reduced is redeposited and forms along with the heavier, oily portion a solid magma within the pores and fibers of the wood.

(2) *A physical action* or choking up of the pores of the wood by the solid magma formed as described above. This prevents the absorption of moisture by the wood and arrests decay.

(3) *A physiological action.*—The antiseptic property of the creosote destroys the organic life in the wood and prevents the development of germs or fungi which are known to be destructive to timber.

By charring the ends and surface of timber you seal the pores of the wood and prevent moisture from creeping up and starting the germ life in the wood which would in a short time destroy the life of the wood. The carbon formed by the charring of the surface of the timber is indestructible.

HENRY LAMPARD, Montreal, Canada.

Second Prize.—ALEX. DIXON, Weir City, Kansas.

QUES. 605.—Cutting Mine Timber.—In what season of the year should mine timber be cut, and why? State all the reasons that you know for and against the cutting of mine timber at such time.

Ans.—The most favorable months for cutting mine timber are December, January, and February. During these months, there is comparatively little sap in the tree. If cut when sap is circulating through the tree, rapid decay of the timber ensues from the fermentation of the sap. If cut during these months, the timber is more readily seasoned by the drying out of what sap is present and seasoned timber will last fully one-quarter longer than green timber. Another argument in favor of cutting timber during these months is that it is much easier to secure workmen for the forest [and transportation to the mines is usually cheaper] during the winter months. [In temperate climates, the circulation of sap in forest timber has practically ceased toward the close of December, but starts again about the middle of February. The only argument in favor of cutting timber in the summer season is the employment thereby given to miners when they are idle.]

D. C. PHILLIPS, Hiteman, Iowa.

Second Prize.—FRANK CRAGGS, East Hedley Hope, Tow Law, Durham, England.

QUES. 606.—Gravity-Plane Haulage.—Calculate the size of rope required to lower an output of 1,000 tons per day of 10 hours, over an incline 300 yards long. The upper landing is 50 feet of vertical height above the tippie. Draw a sketch also showing the profile of the incline, from the tippie to the upper landing. Calculate the starting and stopping grades at the head and foot of the incline respectively, and the uniform grade of the incline. Assume a rolling friction of $\frac{1}{10}$ of the normal pressure upon the plane, and the weight and capacity of the mine cars as 1,500 and 2,200 pounds, respectively.

Ans.—Number of wagons lowered each trip, assuming a speed of 30 feet per second, or $\frac{300 \times 3}{30} = 30$ seconds or one-half minute

for each trip, and allowing also one-half minute for changing ropes, making the time for one round trip 1 minute; then,

$$\frac{1,000 \times 2,000}{10 \times 60 \times 2,200} = 1.515 \text{ cars per trip. Or, say 2 cars per trip,}$$

$$\text{the time per trip will be } \frac{10 \times 60 \times 2,200 \times 2}{1,000 \times 2,000} = 1.32 \text{ minutes,}$$

which gives $1.32 - .5 = .82$ minute for changing ropes.

To determine the size of rope required, we first find the general angle of inclination of the plane (a); thus, $\frac{50}{900} = .0555$



$= \sin a$; whence $a = 3^\circ 11'$ and $\cos a = .9984$. The tension or pull (T) on the rope is then the sum of the gravity pull and the friction pull due to the loaded trip and the rope. Thus,

$$T = (W + w) \left(\sin a + \frac{\cos a}{20} \right) = [2(1,500 + 2,200) + 900 \times .88]$$

$$\times \left[.0555 + \frac{.9984}{20} \right] = 863 \text{ pounds. Doubling this to provide}$$

against shock, and using a factor of safety of 10, we have for the breaking strain $\frac{863 \times 2 \times 10}{2,000} = 8.63$ tons. From the tables giving

the strength of wire ropes, we find this would require a $\frac{1}{2}$ -inch plough-steel rope having a breaking strain of 9 tons; but to provide for wear of rope, we will use a $\frac{3}{4}$ -inch steel rope weighing .41 pound per foot, and having a breaking strain of 13 tons.

In starting the trip from the bottom, where the track is practically level, the gravity pull of the rope and the friction pull of the entire system are the resisting forces. The gravity pull of rope is $900 \times .41 \times .0555 = 20.5$ pounds. The starting friction we estimate as double the rolling friction, or $\frac{1}{10}$ th of the weight of the entire moving load (2 loaded cars = 7,400 lb.; 2 empties = 3,000 lb.; 1 rope 369 lb.). Hence the entire resisting pull

$$\text{in starting is } 20.5 + \frac{7,400 + 3,000 + 369}{20} = \text{say } 559 \text{ pounds. This}$$

is equal to the gravity pull of the loaded trip (7,400 lb.) on the steep pitch. Hence, calling the angle of the steep pitch B , we have $\sin B = \frac{559}{7,400} = .07554$; or $B = 4^\circ 20'$.

After the load has started the resisting pull is

$$20.5 + \frac{7,400 + 3,000 + 369}{40} = \text{say } 290 \text{ pounds,}$$

while the gravity pull of the loaded trip remains constant (559 lb.).

Hence, to find the acceleration (f) of the system, we have

$$f = \frac{559 - 290}{559 + 290} \times 32.16 = 10.19 \text{ feet per second, and the length of the steep pitch is then, } \frac{v^2}{2f} = \frac{30^2}{2 \times 10.19} = 44.2 \text{ feet.}$$

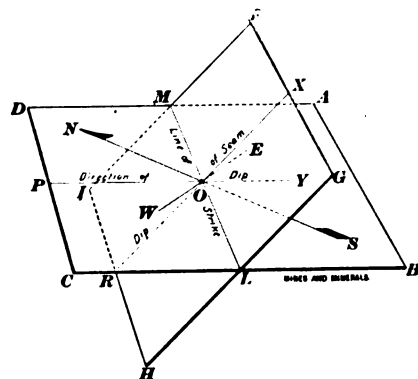
The stopping grade at the foot of the incline will be a practical level of the same length as the starting grade at the top. Correcting for the uniform grade, we find its length is practically $900 - 2(44.2) = 811.6$ feet, and its rise $50 - 44.2 \times \sin 4^\circ 20' = 50 - 44.2 \times .0755 = 46.7$ feet. Then finally $\sin a = \frac{46.7}{811.6} = .05754$; or $a = 3^\circ 18'$, instead of $3^\circ 11'$ as before.

N. G. BOLLING, Greensburg, Penna.

Second Prize.—WILLIAM D. ROBERTS, Graceton, Penna.

QUES. 607. *Strike and Dip of Seams.*—Give a clear explanation of what you mean by the terms "strike" and "dip" in reference to inclined seams.

ANS.—*Strike.* Imagine a horizontal plane surface $ABCD$ intersected by the inclined plane $FGHI$ representing an inclined seam. The line of intersection ML of these two planes being a level line in the seam is a line of strike or the strike of the seam and its direction is measured by the angles $MO M$ or $SO L$ which it makes with a true north and south line (meridian). This angle is always a horizontal angle, lying in the plane of the horizon; thus, in the present case, the strike of the seam may be said to be $N 45^\circ E$, or $S 45^\circ W$.



Dip. At any point (O) of ML draw lines OP and OR at right angles to ML in the horizontal plane and in the plane of the seam, respectively. The angle POR included between said lines is the angle of dip of the seam or the amount of dip.

The line OR is the line of true dip, while its horizontal projection OP is the direction of dip of the seam. The direction of dip is always measured by the horizontal angle NOP , in the horizontal plane. In like manner the line OX is the line of pitch of the seam, and its horizontal projection OY is the direction of pitch measured by the horizontal angle SOY . It is well to note that dip or pitch can only have one direction, while the strike of a seam may be given in two directions.

THEODORE SIMONS, Rossland, B. C.

Second Prize.—JAMES RADFORD, Springfield, Illa.

QUES. 608. *Cleats and Bedding Planes in Coal Seams.*—Explain the terms "cleats" and "bedding planes" in reference to coal seams and other stratified deposits. Also, state if there is any fixed relation between the direction of the principal or face cleats and the inclination of the seam.

ANS.—All beds of rock are divided by natural cracks or "joints," which are perpendicular or nearly so to the plane of stratification. There are usually two distinct sets of these joints or cleavages; the principal or main joints being crossed by lesser joints, more or less square with the main joints. Sandstones, slates and shales possess to a greater or less extent the same phenomena, which quarry men take advantage of just as miners do in the working of coal. Clays (fireclays) and other jointed deposits often have joints which follow no system and are hence called irregularly jointed deposits. Rock joints generally occur in regular, definite directions. The main joints or principal cleats are usually parallel with the axes of the folds or undulatory surfaces of the basins, saddles or areas containing them; but deflections and variations are very common in some coal fields, particularly those much disturbed by faults.

The principal or "face cleats" or "backs" as they are sometimes termed by the miners, cut the coal perpendicular to the stratification or nearly so, and are usually more or less parallel to the strike of the seam; while the lesser or "end cleats" as a rule run parallel with the dip of the seam; but as stated above, geological disturbances vary this rule, giving no fixed relation between the direction of the cleats and the inclination of the seam.

Bedding planes are cleavage planes or partings in the plane of stratification, and represent pauses in deposition, or changes in the character or composition of the sedimentary materials which were deposited in the water. A seam or bed of coal is invariably a series of parallel flat layers or benches of coal of varying quality,

hardness, structure, etc., grouped together so that they practically constitute one seam. These different benches are separated by cleavages or bedding planes and are of varying thicknesses, materials and extents. The bedding planes being planes of stratification are approximately at right angles to the cleats or joints, and are of great advantage to the miner in preparing his coal for the car.

THOS. ENGLISH, Streator, Ill.

Second Prize.—THOMAS CHARLTON, West Leisenring, Penna.

QUES. 609. *Surveying, Precautions Necessary When Surveying With Magnetic Needle.*—What precautions are necessary in surveying with the magnetic needle, in presence of iron or where attraction is liable to exist? State by what means such a survey may be made fairly reliable.

ANS.—Where local attraction exists, whether known or unknown, the bearing as indicated by the compass at one end of a line will differ from that read at the other end of the same line. By reading and noting the magnetic bearings of both backsight and foresight, at each station, the angle included between two consecutive lines or the angle of deflection at each station can be computed correctly regardless of local attraction. The angle of deflection so obtained, at each station, should be used to check the bearings of lines at all the stations of a needle survey. Assuming that the true bearing of the line from which the survey emanates is known, the true bearings of the lines of the compass survey may be computed by this means, and the survey made fairly reliable thereby.

THEO. SIMONS, Rossland, B. C.

Second Prize.—E. MCCORMICK, Siegelton via Luning, Nevada.

QUES. 610. *Ventilation, Effect of Splitting the Air Current Upon the Speed of a Fan.*—The power remaining the same, what effect will the splitting of the air current into two equal splits have upon the speed of the ventilator? State the reasons for your answer.

[A number of replies were received to this question; but though the conclusions were correct in some of them, the reasons given were in error. This suggests the advisability of answering question 624 first, after which question 610 will be answered more readily.—EDITOR.]

QUES. 611. *Furnace Ventilation; Splitting, Pressure Constant.* The circulation in a certain mine is maintained by means of a furnace at the foot of the upcast, but the quantity of air is insufficient for the thorough ventilation of the mine. If it were possible in this mine to divide the air current into two equal splits, would the quantity of air in circulation be doubled by this means? Give the reasons for your answer.

ANS.—The mine pressure remaining the same, the volume of air in circulation will be more than doubled, for the volume of air in each split, pressure remaining the same, will increase as the square root of the number of splits; since for the same perimeter and area, the quantity varies inversely as the square root of the length of airway; and when dividing the original airway into any number of equal splits, the length of each split is inversely as the number; therefore the quantity of air circulating in each split will vary as the square root of the number of splits. Calling the number of equal splits n , the total quantity of air circulating in all the splits after the division, will be $n\sqrt{n}$ times the original quantity. Therefore, if 10,000 cubic feet of air per minute were going through the undivided airway, and this airway be now divided into two equal splits, the total volume in circulation would be (mine pressure remaining the same) $2\sqrt{2} \times 10,000 = 28,284$ cu. ft. per min.

JOHN VERNER, Oskaloosa, Ia.

Second Prize.—JAMES RADFORD, Springfield, Illa.

CATALOGUES RECEIVED.

In writing for catalogues, please mention *Mines and Minerals*.

LATTIMORE MFG. Co., St. Clair, Pa. "Miners' Caps and Lamp Attachments."

JENKINS BROS., 71 John St., New York. "Rubber Specialties." 8 page circular.

VIEWS AT THE MICHIGAN COLLEGE OF MINES, by F. W. McNair, President, Houghton, Michigan. 16 pages.

JOS. DIXON CRUCIBLE Co., Jersey City, N. J. "Some words of Wisdom About Paint." 8 page circular.

A. LESCHEN & SONS ROPE Co., St. Louis, Mo. "Patent Flat-tened Strand Wire Rope." 2 page circular.

ROBERT AITCHISON PERFORATED METAL Co., Chicago, Ill. "Perforated Metals of all Kinds." 42 pages.

DEAN BROS. STEAM PUMP WORKS, Indianapolis, Ind. Catalogue No. 42, 1900. 72 pages well illustrated.

SIMPSON MFG. Co., Winthrop Harbor, Ill. "Simpson Compound Hammer Pulverizer." 4 page circular.

PITTSBURG GAGE & SUPPLY Co., Pittsburg, Pa. "Protection that Protects." Pittsburg Safety Water Column. 10 pages.

OREGON RAILROAD AND NAVIGATION Co., Portland, Ore. "A Brief Sketch of the Gold Fields of Eastern Oregon." 14 pages.

A. LESCHEN & SONS' ROPE Co., St. Louis, Mo. "The Finlayson Patent Automatic Aerial Wire Rope Tramway." 28 pages.

J. E. RHOADS & SONS, Philadelphia, Pa. "Belting Rubber Goods." 96 pages describing many different kinds of rubber goods.

CONSOLIDATED TELPHERAGE Co., 20 Broad St., New York. Circular No. 7. "Aerial Cableways, and Tubular Dispatch." 10 pages.

A. S. CAMERON STEAM PUMP WORKS, East 23d St., New York City, U. S. A. Illustrated catalogue of Steam Pumps, No. 29. 112 pages.

JAMES L. ROBERTSON & SONS, 204 Fulton St., New York. "Time is Money." 12 pages describing the Tic-A-Toc automatic grease cup.

WESTINGHOUSE, CHURCH, KERR & Co., Pittsburg, Pa. 4 page circular containing a list of purchasers of the Improved Roney Mechanical Stoker.

PHILIP CAREY MFG. Co., Lockland, Hamilton Co., Ohio. "Carey's Magnesia Flexible Cement Roofing" 40 pages. Very handsomely illustrated.

RISDON IRON WORKS, San Francisco, Cal. Catalogue No. 4, "Risdon Patent Tangential Water Wheels" 48 pages. No. 10, "Pumping Machinery."

WESTERN ELECTRICAL SUPPLY Co., 10 and 12 N. Ninth St., St. Louis, Mo. "Electric Lighting and Power Equipments for Mines." 4 page circular.

PNEUMATIC ENGINEERING Co., 100 Broadway, N. Y. "A New Method of Pumping Water, Other Fluids and Semi-Fluids by Compressed Air." 15 pages.

MEITZ & WEISS, New York. "Gas and Kerosene Engine." 24 pages showing a great many of the different types of engines and also containing testimonials.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa. Circular No. 1017, "Alternating Current Potential Regulators"; No. 1029, "Polyphase Induction Motors."

JAMES W. SMALLMAN, Nuneaton, Stockingford, M. R. "Small Patent Wire Rope Haulage Clip." Contains a list of a number of users of this patent haulage clip. 8 page circular.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. "Cochrane Heaters for Heating and Purifying Water for Boiler Feed and Other Purposes." 60 pages very nicely gotten up.

CHICAGO BOILER CLEANER Co., 321 Dearborn St., Chicago, Ill. "The Tweeddale Electric Water Purifying and Softening System for Industrial, Waterworks and Laundry Purposes." 8 pages.

ASHLAND TIDINGS, published semi-weekly, by Leeds & Wagner, Ashland, Ore., showing the principal hotels, railway stations, some of the residences and a great many interesting points about Ashland.

RAND DRILL Co., No. 100 Broadway, New York. "Air and Gas Compressors." 135 pages. This catalogue contains views and descriptions of the many different types of compressors made by this firm, and also price lists, etc.

BETHLEHEM STEEL Co., So. Bethlehem, Pa. "U. S. Navy Standard Tensile Specimen, Proposed for Universal Adoption by the American Section of the International Association for Testing Materials, and adopted by the Bethlehem Steel Co. 4 page circular.

ARTHUR KOPPEL. Very elaborate catalogue printed in six different languages and elaborately illustrated by views showing various installation of this well known firm all over the world. It is handsomely gotten up and the cover in red and black is a real work of art.

EDWARD P. ALLIS Co., Milwaukee, Wis. Mining Machinery. Section I, Gold and Silver Amalgamating Mills and Appliances. 80 pages very handsomely illustrated, showing the different varieties of these particular kinds of machinery manufactured by this well-known firm.

INGERSOLL-SERGEANT DRILL Co., 26 Cortlandt St., New York. "Mining, Tunneling and Quarrying Machinery" Catalogue No. 41, 1898, 104 pages very handsomely illustrated showing many places where the machinery manufactured by this well known firm is in use.

JEFFREY MFG. Co., Columbus, Ohio. "Coal Washing Equipments." 88 pages showing a number of plants where these coal washing plants are in use and containing testimonials from some of the firms using them. Jeffrey Mfg. Co., Columbus, Ohio, "Screening Machinery," 18 pages.

GENERAL ELECTRIC Co., Schenectady, N. Y. Catalogue and Price List No. 7529, "T-H Series Open Arc Lamps," 12 pages. No. 7530, "Railway Line Material," 39 pages. "Transformer Testing," 46 pages. Bulletin No. 4,222, "Artificial Light for Manufacturing Purposes"; No. 4,228, "Grooved Trolley Wire."

ST. THOMAS COLLEGE, Scranton, Pa. Catalogue. This College is conducted by the Brothers of the Christian Schools, and its courses of instruction are comprehensive, embracing three departments, Preparatory, Commercial and Collegiate. Particulars can be obtained by applying to Brother Andrew, 331 Wyoming Ave.

GEO. V. CRESSON Co., Department of Crushing and Concentrating Machinery, 141 Liberty St., New York City. This catalogue calls particular attention to the very large crushers made by this company, which are 24 in. $\times$ 36 in. and 24 in. $\times$ 72 in. These are said to be the largest crushers ever built and the heaviest. The company also advertises very large rolls 48 in. $\times$ 18 in., and 60 in. $\times$ 24 in.

History of Working Siberian Mines.

The working of Siberian gold mines dates back only to the middle of the eighteenth century, at which period the first auriferous veins were discovered in the Urals and in the government of Archangel. Gold was discovered in the Ural Mountains in 1744. Several veins situated on the banks of the River Beregovka were worked with varying success from 1800. In 1895, the output was 19.46 poods (703 pounds). In the southern Urals, the first gold reef was discovered in 1799. The Kothkar reef yielded in 1894 about 85 poods (3,089 pounds).

Toward the close of the period 1870-1879, reefs were discovered in the government of Yenisei and the province of Transbaikalia. In 1894-95, gold-bearing strata were found in the district of Marunsk, in the government of Tomsk.

In 1866, the Amur Province was opened to private trade; two years later, mining was begun on the concessions belonging to the Upper Amur Mining Company, in the basin of the Djalinda. At the same period, explorations were set on foot in the Maritime Province, and in 1871 the first gold was taken from mines belonging to a Mr. Yetukof, in the basin of the Amgoun. During the season of 1897, the Amgoun Mining Company treated 10,834 cubic sagens of gravel, from which about 55 poods of gold were extracted, giving an average of 7.825 grams to a cubic meter. On the other hand, the Amur Mining Company took from placers 734 pounds, showing an average of more than 17.06 grams to a cubic meter.

In 1896, the Government dispatched to the shores of the Sea of Okhotsk an expedition which, according to the latest news, has found rich alluvial drifts. There have recently arrived at this port direct from the United States six practical American miners under the auspices of the Russo-Chinese Bank. They are supplied with modern machinery, are men of experience, and go to the Yumen, where rich discoveries are reported. In conversation with one of them, who last winter prospected in the Yukon, Alaska, the idea was emphasized that the whole region about Anadirski and the extreme eastern range of the Stanovoi Mountains, near Bering Straits, would prove as rich as the Cape Nome region, since it was of analogous formation.—U. S. Consular Reports. Translation from book by Baron de Batz.

Decision Sustaining W. A. Lattimore's Patent for Lamp Attachments.

The Lattimore Mfg. Co. has issued the following circular:

"We beg to advise you that in a recent suit brought by our Mr. Walter A. Lattimore, in the Circuit Court of the United States within and for the Southern District of Iowa, Eastern Division, the Lattimore Patent No. 415,720 was sustained, the same having been also adjudicated in the United States Circuit Court of Appeals, Eighth District, December Term, 1899, and testimony is now being taken before the Master in Chancery, appointed by the Circuit Court, to ascertain the amount of damages and profits due the Lattimore Co. for such infringement.

We have heretofore been lenient with dealers who have been handling infringements of our patents, but we now beg to notify the trade that all dealers or retailers handling such infringements hereafter will be summarily dealt with, the same as the manufacturing infringer, and all users or sellers of infringing lamp attachments will be equally liable to us for profits and damages, and we have instructed our attorneys, Messrs. Wiedersheim & Fairbanks, of Philadelphia, Pa., to move for a preliminary injunction at the proper time against all such infringers. We trust that any further legal action on our part will be unnecessary, as we have no intention of annoying our bona fide customers, who handle our goods in the regular way, but every dealer or user infringing our patents will be promptly prosecuted.

Very respectfully,

St. Clair, Pa.

LATTIMORE MFG. COMPANY.

TRADE NOTICES.

The Rand Drill Co., of New York City, has received from the Paris Exposition the Grand Prize and Gold Medals.

The Bethlehem Steel Co., has discontinued its St. Louis office 502 North 2nd St., and the territory hitherto covered by that office will be handled from the Chicago office of the same company.

The Ingersoll-Sergeant Drill Company of New York has received the Grand Prize at the Paris Exposition for its mining exhibit, the gold medal constituting this prize being the highest award given.

The Jury of Award at the Paris Exposition has granted The Bristol Company, of Waterbury, Conn., a silver medal for its exhibit of recording electrical instruments and also have given honorary mention to its recording steam and pressure gauges.

The Jeffrey Manufacturing Company of Columbus, Ohio, was awarded a gold medal, at the Paris Exposition, covering its line of elevating, conveying and mining machinery. No doubt many of our readers who have enjoyed a visit abroad this summer have had the pleasure of seeing the exhibit of this company.

Messrs. James McCrea & Co., 15 and 17 S. Canal St., Chicago, have just issued a new catalogue showing the Climax steam joint clamp. They report an increase of 100 per cent. in their business thus far over last year, and that the clamp has been adopted by the largest consumers in the country. Catalogues will be furnished upon application.

The Tamaqua Mfg. Co., of Tamaqua, Pa., makers of coal washing machinery, and mining tools has found it necessary to have more room. A new office building 22' x 20', 2 stories high has just been completed, which will be used also for the drafting department. The old office rooms will be utilized for additional machine shop room.

The International Boiler Works Co., Stroudsburg, Pa., has almost completed an office building 30 ft. x 35 ft., located some 500 feet distant from its boiler shops. The need of more room, as well as the desirability of being farther away from the noisy pneumatic riveting machines, compels the erection of this building. The trade of this company has nearly doubled in the past 14 months.

As an instance of direct returns from advertising, the Burt Mfg. Co. of Akron, Ohio, reports that it is crowded with orders as the result of an illustrated notice of the Burt exhaust head, which recently appeared. "Any article of merit" said Mr. Warden, manager of the company, "can be pushed successfully through judicious advertising in the trade journals, as we have demonstrated, to our own satisfaction, at least."

The Curtis & Curtis Co. of Bridgeport, Conn., manufacturers of pipe cutting and threading machinery, has just received a cable from its Paris agents, that the Forbes patent die stocks, of which an exhibit was made at the Paris Exposition, have been awarded the grand silver medal, by the board of award. This is naturally very gratifying to the Curtis Co., as the machines exhibited were in competition with others from all parts of the world.

One of the most profitable post offices in the United States is that at Scranton, Pa. The volume of business is unusually large and is steadily increasing, the figures for the first six months of the present year showing more than double the business for the same months in 1893. This is due principally to the rapid growth of The International Correspondence Schools. Seven years ago the schools' postage was barely five per cent. of the total but now one-third of Scranton's postage is paid by the I. C. S. Their postage has increased from an average of less than \$400 to over \$5,000 a month.

The S. Flory Mfg. Co. of Bangor, Pa., has been compelled to add to its plant, and recently it completed and moved into new offices in a brick building 44 ft. x 42 ft., three stories high. This building is provided with four fireproof vaults, and all modern conveniences. On the street floor is a spacious stock room, or salesroom. The company has also about half completed a brick addition to its machine shops, which will, when finished, add about 50% to the present capacity of the works.

The rapid growth of the export business of the B. F. Sturtevant Co. of Boston, Mass., manufacturers of blowers, heating and drying apparatus, engines, forges, electrical equipment, etc., is well exemplified by recent foreign orders for forges which aggregate 200 for Japan, 75 for Russia, 40 for Germany, 32 for Canada, and 24 for Sweden, in addition to large numbers distributed through its London and Continental stores. Domestic demands have likewise increased in the same line during the past few months, large forge equipments having been furnished to several ship building and locomotive shops in the United States.

The manual training, trades and technical schools have also been placing some large orders with this company.

Morse Williams & Co., Philadelphia, Pa., one of our largest manufacturers of elevators, report two particularly large contracts for the month of August—one from the Union Passenger Station at Pittsburgh, consisting of five hydraulic passenger elevators; two hydraulic passenger and freight elevators; six hydraulic freight elevators of the plunger type, all made with the latest improvements and best approved designs. Another large contract from the terminal station, Chesapeake and Ohio Railroad, for two hydraulic passenger and two hydraulic freight elevators. The Morse Williams Co. is among our most progressive manufacturers, and is well equipped for furnishing elevators suited to every purpose. The company is thoroughly informed as to every improvement in its special line of manufacture, and gives perfect satisfaction to its many patrons.

The Bethlehem Steel Company received on Sept. 1st a telegraphic order for a port propeller-shaft to replace the one which broke in the Plant Line steamship "La Grande Duchesse" while off Halifax recently. The owners of the vessel specified that the shaft should be made of fluid-compressed open-hearth steel, forged under hydraulic pressure, annealed and rough-turned, and the order was booked for shipment Sept. 11th. The shaft measured 32 feet over all, was 13½ inches in diameter, and the shipping weight was 15,458 lbs. It was taken in hand under emergency instructions and went forward Sept. 6th, five days in advance of requirements. Among the other orders recently booked by the same company are spare propeller-shafts for the steamers "Ponce" and "San Juan" of the New York & Porto Rico Line; eight forged hollow shafts of fluid-compressed open-hearth steel for use in Cuban sugar mills; and a large number of gun barrels for the Winchester Repeating Arms Co. and Colt's Patent Fire Arms Co.

The Borden & Selleck Co., 48 to 50 Lake St., Chicago, manufacturers of conveying machinery of all kinds, and general agents for the Howe scales, reports being behind on orders for scales and warehouse trucks. The company looks for continued good business through this year, except in sections where crops are poor. Among recent orders completed or under construction, taken by the company are the following for conveying machines: Soo Line, freight handling conveyors run by a Howe 30 h. p. gasoline engine for transferring freight at Gladstone, Mich.; Rutland Transit Co., new warehouse equipped with five freight carriers on incline for handling freight from dock to freight house and to boats; coal handling machinery and coal screens, including rope transmissions and gasoline engines for the following: Koenig Coal Co., Detroit, Mich.; O. S. Richardson & Co., Chicago; Uhrig Fuel Co., Milwaukee; North Ave. Fuel Co., Milwaukee; C. Reiss Coal Co., Ashland, Wis.; and H. M. Benjamin Coal Co., Milwaukee, Wis.; coal and ash handling machinery for the St. Louis Refrigerator Co., St. Louis, and for the Evansville Cotton Mfg. Co., Evansville, Ind.

The proof of the pudding is in the eating of it, and the best testimonial of the value of any machine is its continued and increasing use. The Thornton N. Motley Co., Sole Licensee for Eastern United States and foreign countries for the Jackson hand-power rock drill report recent purchases of this drill by the following firms: Columbian National Railway Co., Bogata, Columbia, S. A.; 2 drills; Niagara Gorge Railway Co., Buffalo, N. Y.; Peninsular Railroad Co., of Mexico, Progreso, Mex.; Spanish-American Iron Co., Santiago, Cuba, 2 drills; Davis Coal & Coke Co., Thomas, W. Va.; Messrs. Van Roosbroek & Co., Brussels, Belgium, 2 drills; Crawford Mining Co., Hazel Green, Wis.; Secretary of Public Works, Tegucigalpa, Honduras; Engineer of Electric Commission, Baltimore, Md.; H. Glaenzer & Perreaud, Paris, France; Arkell & Douglass, New York, for Australia; Dayton Coal & Coke Co., Dayton, Tenn.; Knauth, Nachod & Kuhne, New York, (For Germany), 2 drills; Arthur F. Easton, Perth, W. Aus.; Nichel Copper Co., of Ontario, Ltd., Worthington, Ont.; Harbison & Walker Co., Pittsburg, Pa.; Lawrence B. Gray, Paramaribo, Dutch Guiana; The Michigan & Pacific R. R. Co., Ltd., Zitacuaro, Michoacan, Mexico; R. W. Cameron & Co., (For West Australia), 15 drills. This same company deals in all sorts of railroad equipment, railway, steamship, mining, and contractors' supplies and is prepared to accept contracts for any materials included under these heads at very short notice. Its catalogue contains numerous testimonials from those who have had extensive experience in the use of these drills. Its New York office is 43 John St., and its London office 37 St. Mary Axe, E. C.

The Diamond Drill and Machine Co., of Birdsboro, Pa., the well known makers of the Royal crusher and of diamond drilling machinery, has recently completed and moved into a new office building. This is a brick structure 2 stories high, having a ground area of 90 ft. x 40 ft. and equipped with all modern conveniences. These increased facilities will greatly add to the company's already excellent plant.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *APPEARS* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 608 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Igneous Rocks. Andesites.

Andesite is a lava so named from its abundance in the Andes Mountains. The general appearance is that of a rather fine-grained rock of a gray, lilac, maroon, or reddish color, speckled profusely with little white and black minerals, which on closer examination prove to be small felspars hornblende and more rarely mica.

A typical specimen is of a lavender gray color, of rather a fine-grained texture, speckled all over with small white crystals of andesine felspar, from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in length. Interspersed with these are small black crystals of hornblende. The ground mass in which these crystals are set seems to the eye, to be an amorphous, lilac paste of felspar.

Another typical specimen from the Toltec Gorge, Colorado, is a pale lavender gray rock, speckled with crystals of black mica, some of which are of a bronze or copper tint. Amongst these are also some longer black crystals of hornblende. The ground mass appears as a pink paste of felspar, in which are set numerous small transparent, glossy, oblong crystals, of andesine trichite felspar.

A third specimen is a gray rock with much larger crystals of white felspar than the former, set in the ground mass. The rock sparkles with little black crystals of mica, and would be called a mica andesite.

DIORITES AND PORPHYRITES.

By development of a granular, coarse, or granite like texture, the andesites grade over into the generally older eruptives called diorites or porphyrites.

The typical diorite is a somewhat fine-grained, gray granite-like rock that might readily be taken for a fine-grained granite.

There is no true ground mass apparent; the rock seems made up of an aggregate of evenly divided small hornblende and white plagioclase trichite felspar crystals.

Another variety is very dark from the preponderance of hornblende in it. Its appearance is that of a greenish black rock spotted all over with minute white felspar crystals, and very distinct small crystals of hornblende. The ground mass is fine grained and of a darker gray tint made up of a "pepper and salt" of minute felspar and hornblende crystals.

A diorite containing distinct crystals of quartz in addition to the other minerals would be called a quartz diorite. From the distinctness of the larger crystals and their being porphyritically set in the finer grained ground mass, this would be called a porphyritic diorite, or porphyrite. Sometimes with the microscope you may observe the little parallel striae or lines on the felspars, which are a characteristic of the plagioclase, or trichite felspar. This felspar is the main characteristic of the rock, distinguishing it from syenite and granite, which it otherwise resembles, the felspars in these latter being orthoclase.

An olive or dull sage green tint often appears on the surface of this rock due to the oxidation of hornblende, hence the rock is often designated as "greenstone."

Andesite is an effusive lava, occurring in lava flows on the surface, issuing from dikes or craters. Diorite belongs to the intrusive or Plutonic rocks that have rarely reached the surface. It occurs in dikes and intrusive sheets and forms the bulk of most of our great laccolitic mountains, such as the Henry and others on the border of Utah, and the La Platas and Elk mountains in Colorado.

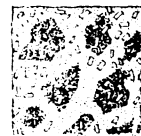
Mr. Cross also includes among the porphyritic diorites, or porphyrites, the great intrusive sheets of porphyry at Leadville, which we have been in the habit of calling quartz porphyries.

From this it would appear that the greater proportion of our so-called porphyries in Colorado, of an intrusive character may be grouped under the "porphyrite" family, and that between andesites, diorites, porphyrites and so-called porphyries there is a very close relation.

ANDESITE BRECCIA AND TUFF.

One of the commonest forms of andesite in the West and especially in Colorado, is not so much the massive rock itself, as the rock broken up into fragments and recemented again with its own material, forming what is called andesitic breccia, when very coarse, and andesitic tuff, when fine, like a coarse sandstone. These forms were produced by explosive eruptions, from explosive vents. The first explosion of a volcano is commonly very violent, the stopper of the throat is thrown into the air and into fragments, some of which fall around the flanks of the crater, whilst others fall back into the orifice and are again and again shot upwards. By this process and the friction against one another in the column of steam, the lava is reduced to very small fragments, or even to impalpable dust, and when later the steam cloud condenses and falls, it brings down with it a shower of these fragments and dust, and sweeps down over the flanks of the mountain in a hideous mud flow, gathering up pieces of all kind and sizes of rock into its muddy embrace, filling up ravines, overwhelming villages and, it may be, overtopping low hills and filling river courses. Such material when it comes to rest "sets" in the adobe form we know as tuff or breccia such as covers the region around Cripple Creek. Sometimes a volcanic orifice is opened near the border of a lake, and the explosive showers of dust fall into the lake, and becoming mud form a semi-stratified tuff deposit of the finest shale, or of coarse conglomerate or breccia. Such we find in the Tertiary lake beds of Florissant a few miles north of Cripple Creek, where the fine tuff shale encloses exquisite impressions of the leaves of trees growing by the lake at the time of the eruption, the fossil trunks of the trees that bore them still standing erect and fossilized, in the mud in which they grew, now turned to shale. The same "tuff" shales also contain well preserved remains of various insects. Alternating with these shales are coarser beds of larger volcanic flows or volcanic breccia. Dr. Cross considers the vast breccia beds of the San Juan region to have been poured out from explosive andesitic vents and to have found their way into an extensive lake. The volcanic breccia beds of San Juan form beds whose cliffs are over a thousand feet high showing the vast amount of material extruded from the volcanic orifices. The appearance in the distance of these great breccia sheets in the San Juan is that of dull leaden gray, sombre masses, often rounded into curious forms by erosion. On closer inspection we see they are made up of more or less angular blocks of andesite usually of a dark lilac or lead gray color, cemented together by a paste of more altered andesite of an olive greenish tint resulting from the oxidation and alteration of the dark silicates, the hornblendes, micas, etc. A cross-section of a block of these andesite breccias with its different colors, lilac, maroon, gray and green, is very handsome and like a mosaic pavement.

The tuffs on the other hand are hardly distinguishable from ordinary coarse or fine sandstones. At Cripple Creek these breccias and tuffs are much oxidized and altered by hot water and subsequent surface action, and it is only now and then that we can detect the material of which they are made. The general fragmental character of the rock easily distinguishes it from phonolites and others. A few massive bodies of andesite occur at Cripple Creek showing distinct porphyritic crystals of felspar and hornblende, as, for example, at the Anaconda mine. In South Park, Colorado, is a remarkable mountain formed of hypersthene andesite called Buffalo Peaks. It is really a capping flow of andesite resting upon other strata. This sheet is perhaps 500 feet thick and shows in parts a columnar structure like basalt. The flow doubtless covers the throat of the volcanic vent from which it was extruded. The rock is called hypersthene andesite from hypersthene, a dark form of pyroxene, very closely allied to



ANDESITIC BRECCIA.



PORPHYRITIC DIORITE. (PORPHYRITE.)



ANDESITE BRECCIA RESTING ON THE ALGONKIAN QUARTZITE, MEARS ROAD, SAN JUAN.

augite. Besides the massive, there are also tuffaceous beds in the lower part of the mountain, some of them loose, friable ash beds, others contain a large amount of pearly glass.

These beds of tuff contain fragments of granite sometimes 6 feet in diameter, shot up from the granite throat of the volcano at the time of its explosive eruption. Granite fragments occur similarly in the Cripple Creek tuffs. The pebbles included in these tuffs represent as many types of massive andesite as are indicated by the various beds. The thickness of these tuff beds of 1,500 feet shows that there was a long explosive period before the massive lava capping the peak poured out.

These tuffs rest on Carboniferous limestone at the base of the mountain. The solfataric or hot spring action, which succeeded the eruption is well shown in the limestone being thoroughly silicified and coated all over with opal and chalcedony like melted wax or candle grease. Deposits of a beautiful white porcelain opal occur among the tuffs. Some of the rocks are coated with a frost-like or glassy scum called hyalite, and on the summit are holes in lava formed and vitrified by lightning.

ANDESITE IN THE ANDES.

As to its occurrence in the Andes Mountains, whence it got its name. Darwin, in his geological observations says: "A rock of Plutonic origin and highly important in the history of the Cordillera from having been injected in most of the great axes of elevation and from having been instrumental in metamorphosing the superincumbent strata has been called by some authors andesite. It consists mainly of well crystallized white albite felspar, of less perfectly crystallized green hornblende, often associated with mica, chlorite and epidote (both green secondary minerals) and occasionally with a few grains of quartz. Where the mica and quartz are abundant, the rock cannot be distinguished from granite. These andesitic rocks form mountain masses of a white color."

"In their general outline and appearance, in their joints, in their occasionally including dark colored angular fragments of some pre-existing rock, and in the great dikes branching from them into the superincumbent strata they manifest a close and striking resemblance to masses of common granite and syenite. I never saw however, in these andesitic rocks those granitic veins of segregation which are so common in true granites. Andesite occurs in three places in Terra del Fuego. In Chili from St. Fernando to Copiapo, a distance of 450 miles, I found it under most of the axes of elevation. In a collection of specimens from the Cordilleras of Lima in Peru, I immediately recognized it and it occurs in Eastern Kamtschatka. From its wide range and from the important part it has played in the history of the Cordilleras I think this rock has well deserved its distinct name of Andesite."

ANDESITE AS A MINING ROCK.

Andesites are a very important class of rock from a mining point of view. Formerly granite was the favorite rock amongst miners, as most fissure veins were supposed to occur in it. Now, in the West, of late years, especially since the discovery of Cripple



DIAGRAM ILLUSTRATING THE SUCCESSION OF ANDESITIC VOLCANIC FLOWS AND OTHER FORMATIONS RESTING ON UPTURNED STRATA.

Creek's gold deposits in andesitic breccia, more and more attention has been given to this rock and its occurrence. It is proving to be, of all lavas, the most singularly prolific one in gold, not merely in Western America, but in other regions of the world. Generally speaking when gold is found to be associated with lava rock at all, that rock proves to be one of the andesite family. In Colorado beside the gold being found in andesitic breccia at Cripple Creek, andesite from a volcano at the Rosita mining region is the principal lava there also giving its gold. Nearly all the fissure veins of both silver and gold of the San Juan region are in this character of eruptive lava, the extent of which in

Western Colorado covers thousands of square miles. The same variety of rock prevails together with diorite, its relative, along the gold belt of the Pacific coast, and in Idaho Territory. It is not too much therefore to call it the gold-bearing lava.

IOWA COAL-MINING METHODS.

The Character of the Coal—Its Influence on the Methods of Mining—The Systems in Use.

Written for MINES AND MINERALS by J. T. Beard, C. E., E. M.

The Iowa coal field is the most northwestern portion of the central coal basin of the United States. The seam of coal most generally worked throughout the State lies at an average depth of 200 feet below the surface of the prairie. The coal field of Iowa covers an area of about 10,000 square miles in the southern portion of the State. The seams present numerous outcroppings in the larger river beds. Geologically it forms the same deposit as the Missouri and Illinois basin. The coal lies in lenticular-shaped basins extending in a northwesterly and southeasterly direction, thus dividing the entire field into a series of local basins varying in width and length. The faults are almost without exception those due to erosion. These faults for the most part have the same general direction, from northwest to southeast. The seams of the entire field present little or no inclination. The floor of the Iowa coal is generally a fireclay, which is hard when dry but becomes soft and yielding when the mine is wet.

The general character of the overlying strata is a succession of shales, sandstones, and limestones of varying thickness but of a generally yielding nature, forming a strong and good roof for mining purposes. There is no gas found in any part of the State.

Character of the Coal.—There are in most parts of the coal field three distinct seams, of which, however, only the lower seam is generally worked. The thickness of this seam varies from 4 to 7 feet. The character of the coal varies from medium soft to a hard brittle coal that shoots with difficulty. The coal is a bituminous coal of excellent quality for steam purposes as well as for domestic use. In certain localities some sulphur occurs in the form of sulphur balls and streaks of pyrites, but this is only local. There is quite frequently overlying the coal seam a draw slate which comes down readily when the coal is taken out. While this is an advantage in entry work, as the fall of the slate increases the height of the entry, it often makes the roof in the rooms very heavy and difficult to manage, and is the cause of frequent accidents. In the southern portion of the State, around Centerville, there is a large area of a very uniform thickness of good coal. In this section the seam is divided near its center by a 2½-inch clay parting. The coal, also, in this section has a definite cleat, often requiring the breasts to be driven in a given direction. This feature does not occur elsewhere in the State. The Centerville seam is not generally believed to be of the same age as that of the seam worked in other localities. It has been found to exist, however, as far north and east as Monroe county. The coal of this seam is of excellent quality. Careful borings are now being made near Centerville to prove the presence of the lower seam in that locality. A characteristic of the upper Iowa seams is the purity of the coal which makes possible the working of these thinner seams in many localities.

Thickness of Entry and Room Pillars.—The conditions with respect to floor and roof are often such as to induce a squeeze, if sufficient care is not given to the providing of sufficient width of entry and room pillars. This is particularly the case when a hard sandstone or rock cuts out the roof shale. The usual thickness of entry pillars adopted is, for the main roads 6 to 8 yards, for the cross-entries 5 to 6 yards, and for room pillars 3 to 5 yards. It is customary, however, in approaching the point where a cross-cut is to be made in a room pillar, to draw in gradually, at this

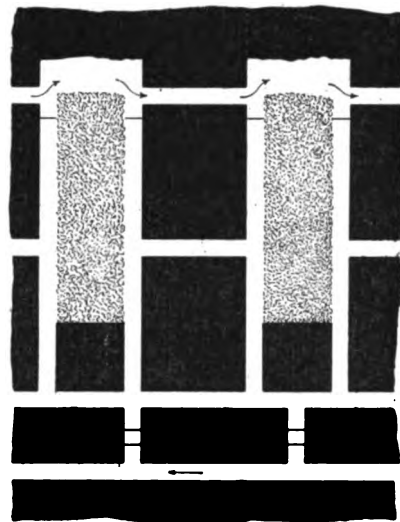


FIG. 1.

point, in order to decrease the thickness of the pillar and to lessen the length of the crosscut.

Systems of Working.—The systems of working generally employed are the *room-and-pillar* and *longwall*. The room-and-pillar system is slightly modified, at some of the mines, by driving up narrow rooms with wide pillars, and drawing back the pillars. This is a practical system of *pillar and stall*. It is adopted, however, only locally, in some few instances. Another modification of the room-and-pillar system quite frequently found is that of driving *double rooms* with a wide breast varying from 15 to 20 yards in width, separated by pillars of 8 or 10 yards in width (see Fig. 1). A roadway is carried up each rib. Still another modification of the room-and-pillar system is one in which rooms are driven in sets, there being from 6 to 8 rooms in a set.



Fig. 2.

The breast in these rooms is carried forward in one continuous line, there being two fast ends requiring to be cut in each breast. Each set of rooms thus forms practically a separate panel in which the coal is mined longwall. This is, therefore, in some respects a modification of the panel system. The panel breast is often spoken of as "a longwall breast" in such cases; but it cannot be considered as longwall work, within the general significance of the term *longwall*.

Room-and-Pillar System.—In this system the main haulage roads run both ways from the shaft, and from these cross-entries or haulways are driven to the right and left. The double-entry system is almost invariably used in the larger mines; the single-entry system being used only in some local mines. Rooms are driven off both entries of each pair of cross-entries. The rooms are generally spaced from 33 to 40 feet, center to center. The breasts usually vary from 8 to 10 yards in width, with pillars varying from 3 to 4 yards. The rooms vary in length from 50 to 100 yards according to the character of the roof and floor. The usual practice is to turn the rooms narrow for a distance of 3 yards and then widen upon the inbye rib, at an angle of 45°, till the full width of the breast is obtained. The road is carried along the straight rib. A plan of a typical Iowa mine of this description is shown in Fig. 2.

Longwall.—The system of longwall generally employed is that in which a main-haulage road runs in each direction from the foot of the shaft. From this, diagonal roads are turned upon both sides of the main road, at an angle of 45°. Working places are opened off these diagonal roads at an angle of 45°, or parallel to the main haulway. These working places are spaced about 10 yards apart, and are usually driven a distance of 50 to 60 yards, when they are cut off by another diagonal road.

Pillar-and-Stall Work.—This is only employed locally where the conditions of roof and floor require it. The stalls, though sometimes turned off the entry at their full width (4 yards), are usually turned narrow and widened inside. The thickness of the pillar varies from 5 to 8 yards. The stalls are usually driven from 30 to 40 yards in length and the pillars drawn back. The stalls are sometimes driven in pairs, when a wider pillar, varying from 8 to 10 yards, is carried between them.

Double Rooms.—The method of driving double rooms or breasts is often employed. The mouths of the rooms are usually spaced 40 to 50 feet apart and are turned narrow off from the entry for a distance of 4 or 5 yards. A cross-cut is then made connecting these openings in pairs and a breast of about

16 yards is driven up a distance varying from 50 to 60 yards. The width of the pillar separating each pair of rooms varies from 12 to 15 yards.

Panel Breasts.—This method, shown in Fig. 3, is one quite frequently adopted where the conditions are such as to induce a squeeze. Rooms are turned narrow off the entry in the same manner as in the room-and-pillar work, but are arranged in sets of from 6 to 12 rooms in a set. A large pillar is carried between each set of rooms. The thickness of this pillar will vary from 10 to 20 yards, according to the conditions inducing a squeeze, with respect to roof and floor. When the rooms have progressed a short distance from the entry, those in each set are connected by crosscuts and a longwall face is carried forward from this point. There are two fast ends requiring to be cut at the outer ribs of each set of rooms. Packs are built and the roof allowed to settle the same as in longwall working. The wide pillars separating each set of rooms are won later, after roof settlement has taken place.

Ventilation.—The system of ventilating the workings usually employed is that of conducting the air to the inside workings, by means of an air course forming the back entry of each haulage road. From this point it is carried along the face of the rooms, through the breakthroughs or crosscuts in the room pillars, returning thence to the haulage road, which is usually made the return airway. When, however, the mine is ventilated by means of a furnace or an exhaust fan, the intake airway is usually made the haulage road in order to avoid doors at the shaft bottom. It is customary to ventilate each district of a mine separately by means of air-bridges or air-crossings whenever the development will warrant the expense of building the crossing. For this purpose overcasts are generally used built of wood.

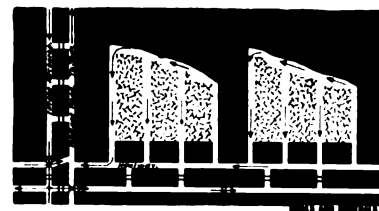


Fig. 3.

Siberian Climate and Agriculture.

There is no doubt that the climate of Siberia is more rigorous than that of any other country in the same latitude. The northern shore is washed by the Arctic Ocean, whence the polar winds sweep unimpeded over the whole country, while the great central Asiatic range shuts out the warm southerly and southeasterly breezes. Hence, the regions of Siberia enjoy a more inclement and less equable climate than places of corresponding latitude in Europe and North America (except the northern placers in the interior of Canada, which, however, profit in summer by certain warm-air currents from Mexico and the Antilles which temper the climate to some extent).

Siberia may be divided from north to south into three great zones.

First. The polar zone, or the zone of the "Toondea," stretching from the polar seas to the polar circle, with outlines somewhat irregular. Vegetation in this region is reduced to grasses, mosses, and lichens. The soil is perpetually frost bound.

Second. The forest zone, extending from the polar circle to the fiftieth or the fifty-fifth degree of latitude, characterized by thick forests intersected by swamps.

Third. The cultivable zone, stretching south to the Chinese frontier. In this zone the summers are warm and genial. Wheat, rye, and oats can be grown, and stock raising may be carried on. Almost all of the efforts of the colonists have been concentrated here. This comprises at present the four governments of Tobolsk, Tomsk, Yenisei, and Irkutsk, leaving out of consideration their most northerly districts and the mountainous portions of the government of Tomsk, Yenisei, and Irkutsk lying near the Chinese frontier. It also includes the regions watered by the Amur and the Ussuri, sparsely populated at present, but rapidly being settled by immigration under the reduced rates on the Great Siberian Railroad now completed to Stretinsk, east of Baikal. This zone contains approximately 54,000,000 acres, with only 5,380,000 acres under cultivation. The system of cultivation is still primitive. The land is first cleared, the trees are felled, stumps are removed, or on the steppes the soil is merely plowed. The ground is next sown with wheat for two or three years consecutively. It is then allowed to lie fallow, and subsequently is again sown with wheat. This rotation is continued until the ground shows signs of exhaustion. The land is then left completely uncultivated, and other fields are tilled in the same careless manner.—U. S. Consular Reports, Translated from Book by Baron de Batz.

EXPLOITING A NEW PLACER FIELD.

Some of the Considerations to be Taken Account of, as Illustrated at Fairplay, Near Alma, Colorado.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

There is a certain charm as well as a good many peculiar difficulties to be met with in the opening up of an entirely new untouched property. It is fraught with all the romance and expectations of possible great things; no one knows, no one can tell for sure, and therefore there may be great things below the sod, and it is the tendency of the human imagination rather to exalt than depress future possibilities and grand uncertainties. Such is the case with an untried placer field covered at present by pasture, and fed upon by herds of cattle. It is proposed to transform this pleasing meadow from a farm ranch into a placer ground and to deluge the green sward with tons upon tons of dirty water, silt, mud and pebbles through the agency of hydraulic elevators and other appliances of modern gold placering. But before these mighty engines can be brought on the ground and before in fact the ranch is actually bought or leased a great deal of prospecting and probing, theorizing, speculating and surmising has to be done and efforts made first to find whether there is any right to expect gold under the sod; secondly, whether experiment shows there is positively any gold, and approximately how much on an average, and whether, taking all things into consideration, it will pay to work on a large scale after the ranch is bought or leased.

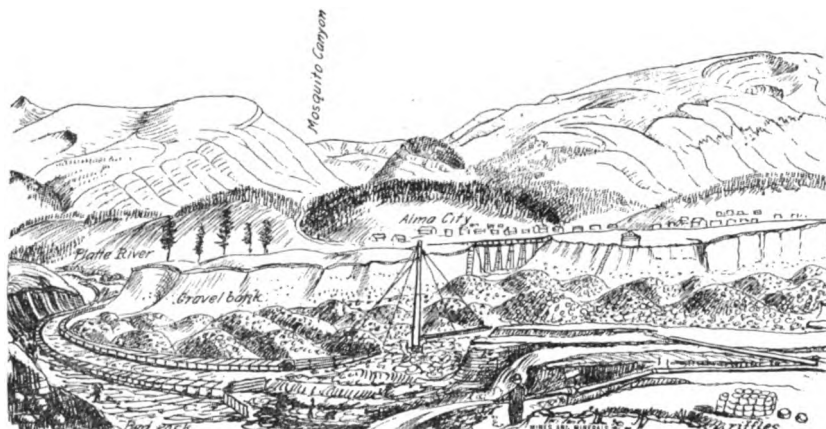
We will now describe or sketch the location of a typical new placer and its surroundings. The placer is on a certain ranch area in the broad flat flood-plain valley of the Platte River, about ten miles south of Fairplay in the South Park of Colorado.

South Park is an elevated meadow-like rolling basin, high up 10,000 feet in the heart of the Rockies of Colorado. In early geological periods it was for a long time an arm of the sea, or almost an inland sea, whose waters during many ages laid down in its basin on the granite flanks the whole known geologic series from the Cambrian, Silurian and Carboniferous or Paleozoic series of quartzites, limestones, grits and sandstones to the topmost strata of the Mesozoic, with the red Jura-Trias sandstones, shales and limestones below, to the marine Cretaceous sandstones, shales and limestone and coal-bearing strata above.

The Park is a basin scooped out of granite, and overlaid by

of two or three varieties of so-called porphyries or porphyrites, which appear to have had considerable influence in the deposit of ores of gold and silver at their contact with the metamorphosed sedimentary rocks.

Such are the geological surroundings from which the gold of the placers of the region and the placer meadows have been drawn. Looking up from the placer meadows in question we see the hills all around it on the north and west to be furrowed by deep cañons, cutting the Mosquito Range with all its aforementioned strata to the very core. These cañons all drain into the Park, and it is evident that whatever material the glacier or stream once occupying them carried out from them was carried into the Park, and the first coarse mass was dumped along the path of the cañon in the retreat of the ice and also at the entrance, while the remainder

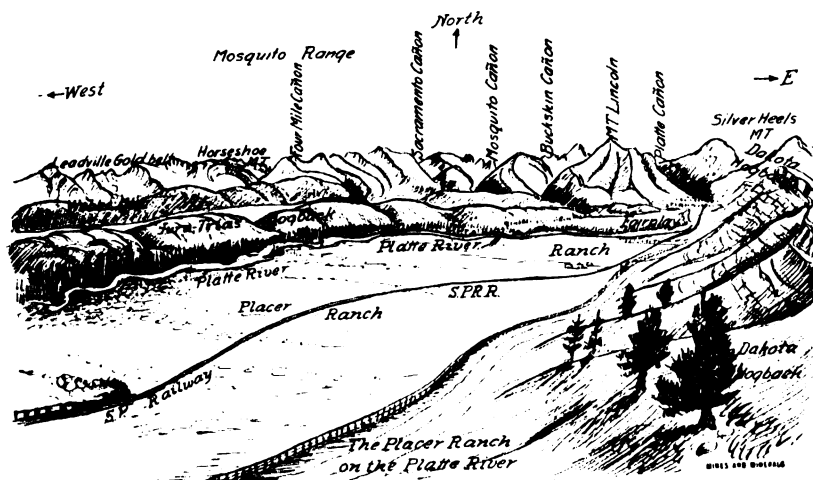


PLACER WORKINGS, ALMA BASIN.

and finer material was washed down by the broad rivers of the time into the Park and there sorted and its gold deposited.

Foremost among these cañons is that at whose head, under Mt. Lincoln, are the various sources of the Platte River whose waters flow through the meadow in question. If we follow up the stream we arrive at Fairplay, where the glaciers from the foot of Mt. Lincoln appear to have dumped their great terminal and very coarse moraines. Through this, but not cutting down to bed rock, flows the Platte River. This placer ground has been worked more or less for the past 30 years by Chinese and others on a small scale, but no attempt till lately has been made to sound the placer deposit and find bed rock. This has now been successfully accomplished by the Cincinnati Co. at a point two miles below Fairplay and bed rock reached at 35 feet below the bed of the stream, making the entire thickness of deposit about 100 feet. This fact being ascertained the company is now laying extensive plans for working back down to bed rock the whole bed of the stream for several miles by hydraulic elevators and dredges. To accomplish this they have secured a powerful 300 ft. head of water on either side of the river some two miles up stream. The water will be carried down to work the nozzles in the elevator two miles distant. The pipes come in from streams on either bank of the main stream. One pipe 20" diameter coming in from the north side is connected with a 4-mile ditch, and another from the south side 30" in diameter is connected with a 2-mile ditch derived from the Sacramento River; they meet in a V shape and connect with the main pipe which is 32" diameter and which is carried along on trestles above the river bed, the river course being deflected by a dam till the elevator is reached. After this they may gradually work down to bed rock as far as desired up stream.

Leaving Fairplay and following the course of the stream up to the foot of Mt. Lincoln we find the whole way lined with rolling mounds of boulders left by the great Mt. Lincoln Glacier. At Alma, some ten miles from Fairplay, we find hydraulic mining in active operation under the charge of Mr. Fortune. Work has been successfully carried on here for many years upon banks of material which appear to have been laid down by the Mt. Lincoln glacier combined with tributary glaciers from Buckskin and other cañons all draining gold-bearing areas. The work here consists of cutting down banks by pipes and sluices and hydraulicking them to bed rock, as well as ground-sluicing them. An account of these typical hydraulic placers we gave in THE COLLIERY ENGINEER AND METAL MINER some years ago. The bed rock consists of a coarse



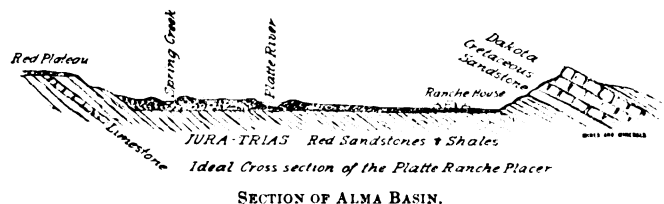
VIEW OF ALMA BASIN.

sedimentary beds of the Paleozoic and Mesozoic ages. These strata by the uplifting of the granite are tipped up all around the edges of the Park to the tops of the mountain ranges. These ranges have subsequently been deeply scored by glacial and river cañons, which debouche into the Park. Any one of these cañons shows on its cliffs a complete anatomy of the geological structure of these ranges, which we find to consist below of granite or gneiss traversed by quartz fissure veins, carrying locally more or less ores, and overlaid above by Cambrian quartzites, Silurian limestones and Carboniferous limestones, with locally a capping of Weber-grits of the middle Carboniferous. All these strata from the granite upwards are more or less traversed by igneous dikes

Weber-grit sandstone; on this and in its crevices the richest gold is found, and the bed rock is cut down several feet and thoroughly investigated with knives and brushes before it is abandoned. This bed rock, which lies at a gentle angle, is overlain by from 50 to 75 feet of gravel, consisting of sand, gravel and large and small boulders principally of porphyry, quartzite and granite. The gold is richer near the base of this gravel than in the upper portions, though all is worked from grass-roots to bed rock. The gold is fairly coarse and several good-sized nuggets have been found. We can follow the same placer formations to Montgomery and the Hoosier Pass at the base of Mt. Lincoln. Here the whole mountain has been cloven by glaciation in a stupendous cliff from summit to the river valley, showing the anatomy of the mountain, which consist, at the top, of a laccolitic body of quartz-porphyrity with dikes of porphyry ascending to it from the granite below and sending out wedge-like intrusive sheets into the sedimentary beds of limestone and quartzite overlying the granite. The granite itself is traversed from top to bottom by a series of large parallel pegmatitic veins of quartz and white felspar, several of which have been exploited and found to contain gold-bearing pyrites. Just at the foot of the cliff is a deep pond or small lake into which the Platte tumbles in waterfalls from a U-shaped glacial cañon at the back of Mt. Lincoln, where the stream has its source in several beautiful glacial lakes or tarns hollowed out of the solid granite by past glacial agencies. It has been thought by some that this deep pond or lake into which the waterfalls pour must contain a "pot of money sufficient to cover the whole indebtedness of the United States;" and several schemes have been thought of to coffer dam it and explore its bottom. But it is a curious fact that such inviting looking "pot holes" have in the experience of placer mining proven often very disappointing. They have often proven to be a clean worked out basin in which no gold was left deposited, and the gold that may have been carried into them is more often found washed and carried out of them a little further on the rim of the basin rather than in its depth. It is from this region, however, that the main source of the gold seems to have come, probably from porphyries, granites, and quartzites.

The success at Alma encourages the new undertaking at Fairplay in glacial placers and tempts the further undertaking in the glacial-river deposits of the Park and Platte Valley and of the placer meadow in question.

Returning again to our placer meadow. The surroundings and other considerations being favorable, the next point to consider is the meadow itself. What are the probabilities of gold beneath the grass, and if gold is there, in what paying degree? Over what area is it paying, what is the depth to bed rock and where are the principal channels? Many of these points will later be proved certainly by practical experiment, but before that, what can we say theoretically about it? First it is evident that the placer is a river deposit and not a glacial one, this is shown by the fact that the pebbles encountered are generally small and well-rounded by water rather than by glacial action. Secondly, as to the location of probable channels old and new. The meadow lies between two banks, one of red Jura Trias sandstone on the west, which is more or less hugged by the modern stream, and by a lofty hogback of Dakota sandstone on the east, the two banks being upwards of a mile apart. On the flanks of the eastern Dakota hogback there are no traces of pebbles, it is evident that the ancient stream did not swing to that side and the shore line deposits at its base appear to be shallow, so we need not look for the main channel on that bank; on the other hand, the red bank at the west to its summit is strewn with pebbles which are larger a great deal than those on the eastern rim and are often piled up on the banks; however the present surface of the meadow slopes toward the west side, it



is evident then that the deepest and main channel lies in this western direction and that here will be found the thickest and deepest deposit of placer material.

As to the general existence of gold over this tract, this can be ascertained in a preliminary way by panning the streams and water courses, by digging short holes here and there and by putting in short sluices, should these prove satisfactory. Then a more systematic prospecting should be carried out over a large area and for a considerable length of time. This should

be done by a systematic series of borings put down by an ordinary churn drill, not by a diamond-core drill as the latter will not work amongst loose debris. There are several patterns of churn drills, but the one that appears at present most popular is the Star drill.

These holes should be mapped out over the meadow and a record kept of panning at every foot or so, and the gold kept in labeled bottles and a diagrammatic record kept of the character of the material pierced. By this means also the depth and character of bed rock can be ascertained at various points and where gold is found on or in it. In this way an underground map can be made of the whole meadow, its values and bed rock. In this particular instance the geologist can form a pretty good idea of what the nature of the bed rock will be. He knows from its geological position that it will belong to the Jura-Trias period and will consist mainly of uptilted red sandstone and shales. The dip of these also he easily ascertains from the exposures on the banks; he finds this to be about 45° and to the east. In this uptilted condition they will prove fairly good natural riffles for catching and arresting the gold as it is borne side-long along their edges down stream, but not so good as if their upturned edges lay transversely across stream.

The ground having been well prospected for a period of several months and some certainty as to its value having been attained, the elevators may be ordered and placed on the premises. The Evans elevator of the Risdon Works of San Francisco appears at present to give the greatest satisfaction. The elevator should be located at the farthest down-stream locality of the meadow with a view to working up stream. Of the mode of working the elevator we shall speak later more fully in our description of its actual working at the Breckenridge placers. Besides the elevators at that locality there are various other machines being used, such as excavators and dredges, all of which have their peculiar merits and are adapted more or less for particular soils and locations. Some of these we shall describe in another article.

SODA SALTS AS BOILER COMPOUNDS.

What the Various Salts Are and the Effects They Have Upon the Various Substances Found in Steam Boilers.

By W. H. Edgar.

Through the courtesy of Mr. W. H. Edgar, President of the Dearborn Drug and Chemical Co., Chicago, Ill., we are enabled to publish the following answer to an inquiry addressed to that company relative to the action of various soda compounds often used in boiler practice.

The following salts of soda are soluble in water, more so in hot solutions and they will not precipitate out of solution until the solution becomes saturated so that it will not hold a larger quantity in solution, when the salt of soda will cake at the bottom or hottest parts of the vessel.

Caustic soda, commonly known as concentrated lye (sodium hydrate); *soda ash*, which is carbonate of soda and, when in crystal form, is known as sal soda or washing soda; *bi-carbonate of soda*, the same as carbonate of soda except it only has one half the quantity of soda, the other half being displaced by hydrogen; *sulphate of soda*, which is commonly known as Glauber's salts; *chloride of soda*, or table salt; *nitrate of soda*, found in large quantities in South America and used as a fertilizer, and also in obtaining or producing saltpeter; *fluoride of soda*, which is the combination of hydro-fluoric acid and soda; *phosphate of soda*, which is the result of the phosphoric acid and soda, etc.

Sodium salts are not volatile nor will they evaporate or carry over as a gas by distillation or sublimation, hence the soda found in the condensation, in the engine cylinder and through the steam system does not volatilize and carry over or pass over by itself; it is carried over mechanically and not chemically or physically.

If steam is perfectly free from moisture when delivered from the boiler, it will not contain or carry any soda, as it is the moisture which holds or contains the soda salt in solution and, if this moisture is left behind, we also leave all trace of soda behind.

If one pound of soda, that is, caustic, sal, or soda ash, or any salt of soda, were dissolved in a given quantity of distilled water and the water boiled and evaporated, the entire amount of soda would remain; there would be no loss whatever. You would recover all the salt you had in solution, except careless boiling causes the water to be spattered out of the dish; of course all solid body of moisture spattered and lost contains just so much soda. This is the only possible way you could lose any part of the salt you have in solution.

The term "salt" is applied to the combination of an acid radical and a base, which forms a neutral salt. Soda combined

with different acids forms sodium salts. Lime combined with different acids forms lime salts. In the same way magnesia or any other base combined with a corresponding acid radical forms a neutral salt, named correspondingly with the acid radical with which the base is combined. So the term "salts" means all such.

Soda ash, or washing soda, and caustic soda are used to make soap. Soap is the result of the action of the soda base combining with the fat or oleic acid, forming oleate of sodium. This gives us soluble soap. The carbonic acid gas, combined with the soda, as carbonate of soda or soda ash; or the hydrate combined with the soda as caustic soda, is easily and readily displaced by the oleic acid, the soda having a greater affinity for the oleic acid than it has for the carbonate or hydrate radical. This is called saponification. You know very well what soap would do in the boiler; you know its action in the water; it forms a suds; it foams. Now, the soda has the same action on the water without grease or soap. We do not, nor can we, get this action from a chloride, a fluoride or a nitrate of soda. These three, chloride, fluoride and nitrate belong to the same group; their physical and other peculiarities are very similar. The affinity between the soda and these acids is so great that it will not go to another acid radical, consequently we cannot saponify the water and cause foaming by the use of these salts nor by use of phosphate or sulphate. But a sulphate will give off to some extent, softening the water by breaking up into a hydrate when in a boiling solution.

If you introduce caustic soda or soda ash into your feed water, you saponify the water in your boilers, causing it to foam, to form suds, which breaks up and spatters the steam, and the water becoming more sudsy, the steam is spattered that much more, and these little, minute, solid sheets of water are virtually blown over. The great velocity with which the steam is leaving the boiler carries this moisture over mechanically and, when you have soda in solution, naturally any part of that solution carried over takes over just so much soda. Any grease or dirt that may be in the boiler or water will cause just so much more of this saponifiable condition, and therefore it will cause the foaming to be more violent.

Soda ash or caustic soda carried into the cylinder of the engine cuts the cylinder oil, forming soap with the animal or vegetable part of the cylinder oil and mechanically coagulates into a sticky, non-lubricating mass the mineral part of the cylinder oil; consequently your lubrication is destroyed. The same action takes place in a boiler where you have oil coming back in the returns. Soda carbonate and soda hydrate saponify the animal oil, forming soap, which gives you violent foaming, and at the same time it cuts and coagulates the mineral oil into a mass.

A word on oils. Where you are constantly buckling the tubes in a water tube boiler, or bagging the sheets in a tubular boiler, or the back ends of the tubes of a tubular boiler are constantly leaking, it is due to oil coming into the boilers with the returns. The animal or vegetable oil, combining with the lime and magnesia as oleate of lime and magnesia (most of the lime and magnesia being in the form of a carbonate) the carbonic acid is readily displaced by the oleic acid. These oleates of lime and magnesia are insoluble, because the oleic acid has combined with an insoluble base. This oleate of lime is formed on top of the water in little globular masses, which are very adhesive and sticky; they gather together, forming into a mass, and then become of the gravity equal to the gravity of the water and are carried buoyantly with the circulation. They always adhere mostly around the ends of the tubes or in the lower water tubes, because this substance has a greater affinity for the hotter metal than for the cooler parts of the boiler, adhering to a hot surface more rapidly. Being a perfect non-conductor of heat, it concentrates and checks the heat in these parts, preventing the water from absorbing the heat, consequently the metal is brought up to such a degree of heat that it melts; the pressure within forces the metal out, buckling the tube or forming a bag. The mineral oil combines with the lime and magnesia as a mechanical mixture in a coagulated, sticky mass, incorporating with and forming a part of the general mass, all of which is insoluble and very adhesive. This *mechanical mixture* is also formed with common salt (chloride of soda), or the fluoride or the nitrate of soda. Any one of these three will form a more sticky, tenacious, adhesive, coagulated substance mechanically with the oil, both mineral and animal, and in a hot solution far worse than the combination with lime or magnesia. This is formed because the affinity of the fluorine, nitrogen and chlorine with soda is so great that it does not break up but enters into a mass with the oil; so wherever you may be getting a little oil back in your returns, a fluoride or chloride of soda will cause your boiler to leak and bag more quickly and the action is more vicious than the action with lime.

When we say lime, we mean the natural scaling salts in feed water. Now, where you are using the average feed water, you have carbonate of lime and sulphate of lime, which form scale and, when you use ash, it is for the purpose of furnishing carbonic acid or carbonate to give you a double salt or enough carbonate to make your lime soluble as it originally was in solution as a bi-carbonate. But you readily see that you have your soda in solution, consequently you get the soda action, foaming, etc.

Hydrate is used because lime salts are soluble in an excess of the hydrate but this excess gives you the same trouble. Chloride of soda has no action on the lime, as the chlorine has a greater affinity for the soda than it has for the lime. Fluoride is introduced with the object of converting the lime carbonate and the lime sulphate into fluoride of lime which is a flocculent light precipitate. But you readily see that where the fluoride goes to the lime, the soda goes to the carbonate with which the lime was combined and leaves the soda ash in solution, so that at the end of two weeks or one month's run the solution in the boiler is saturated with soda ash. Consequently you get a soda action, the water is saponified and carried over, and the valves and connections are all eaten out from the same old soda action.

Then again the fluoride of lime, which is formed and which would remain as such in a cool solution, is broken up to a great extent in hot solution, due to high heat in a steam boiler, which the average chemist does not stop to figure and think of. When this fluoride of lime breaks up, you get the oxide of lime and free hydrofluoric acid. The hydrogen of the water combines with the fluorine, forming hydrofluoric acid and, the oxygen of the water goes to the lime, forming oxide of lime. This hydrofluoric acid liberated attacks the metal and eats the iron, it being much more corrosive and vicious even than sulphuric acid. The oxide of lime forms a scale just as readily as the carbonate, and therefore causes just as bad trouble.

Soda is so extremely cheap that the fakirs, who have a living to make, can afford to sell any preparation of soda and make a thousand per cent. profit; and, the prices that they get are such that all they need to do is to sell one or two kegs per week. They care not for your boilers and if they did, their knowledge would not help them out. They know nothing about what they are selling but they are good talkers and tell the same story as that with which all soda dopes have been handled in the last twenty or thirty years.

If you are going to use soda, buy your own. Phosphate of soda, whether it be tri-sodium phosphate or the other soda phosphates, is used with the same purpose in view; that is, of converting the lime carbonate and the lime sulphate into phosphate of lime, known or claimed to be tri-calcium phosphate. But you readily see that the phosphate going to the lime, the soda must go to the carbonate, sulphate, or hydrate, and you get the same action, the results are always the same, the soda ash being left in solution.

You will notice one thing. They will all explain to you the action on the lime but they do not tell you what becomes of the soda. The man who is selling it does not know; the chemist who got it up does know, but he takes good care that you do not know through any fault of his. When a water is too pure and not satisfied with lime or some proper substance the return condensation or distilled water attacks the iron. The action is termed electrolysis; more commonly speaking, galvanic action. Whenever you add soda to too pure a water so that you have an excess of same over the lime, you then have too pure and an unsatisfied water, which immediately acts as the electrolyte between your poles, giving you the battery connected, and your positive pole, which is always the iron, is destroyed; consequently the pitting, grooving, etc., and general action on the joints and connections takes place.

The only salt of soda that can be successfully used is the tannate of soda and then only when used with four times its weight of tannin. Also with a large excess in weight of sugars, mixing the sugars to handle the sulphates and the tannins to handle the carbonates. These mixtures can be used without any foaming or deleterious action to the iron. It is a subject in organic chemistry all by itself. You can buy these substances at the wholesale drug trade. The reason these soda dopes and soda salts have been used so extensively throughout the country in spite of the fact that the joints are all leaking, steam connections are clamped up with protectors, and the boilers only half clean, is due principally to the user being under the persuasive power of some salesman or man whose business it is to keep the user worked up on theory and talk. But, if an engineer would read chemistry he could figure out the reactions, remembering that there is always a by-product and a main product and when he figures out the main product, he must be sure and figure what becomes of the by-product. When we take, we must give in all chemical reactions. We must take, and, if we do not give, we must produce.

THE MINES LAW OF ONTARIO.*

The Provisions of the Law in Regard to Prospecting and the Acquiring of Mining Locations, Etc.

By Archibald Blue, Toronto.

In Ontario, as in all the older provinces of Canada, the Legislature may exclusively make laws in relation to the management and sale of public lands. The Province is the owner of all unoccupied lands within its boundaries, excepting areas which have been set apart as Indian Reserves; and even on these reserves the title to gold and silver, if not to all ores and minerals, is vested in the Crown as represented by the Executive of the Province.

In the early period of our history mines, minerals, and ores were not deemed worthy of being dealt with by statute law. During the first thirty years all mines of gold, silver, tin, lead, copper, iron, and coal, were reserved to the Crown in the patents, and in the next forty-four years all mines of gold and silver were so reserved. For three-quarters of a century regulations made by Order in Council were the only mining laws. But this was largely owing to the fact that the southern portions of Ontario, which were the first to be occupied, were valuable chiefly for agriculture. It was only when exploration began to be carried northward into the regions of the Archæan rocks around Lake Huron and Lake Superior that evidence began to accumulate of the existence of valuable ores and minerals, and then the importance of making laws to regulate the sale of mining lands and the conduct of the mining industry began to force itself upon the attention of the Legislature. It was known eighty years ago that deposits of iron ore existed in the eastern part of the Province; but the valuable discoveries of minerals south of Lake Huron, Georgian Bay and Lake Nipissing are comparatively modern. Gold, copper, corundum, arsenic, mica, apatite, gypsum and salt occur over a wide area, and some of them in great bodies. Yet, with the single exception of gold, a knowledge of the presence of these minerals in lands occupied by farmers and lumbermen did not weigh a grain in the mind of the Legislature,—no doubt owing to the fact that in most cases the Crown had parted with its interest in the lands. In the western counties, between Lake Huron and Lake Erie, there is an area of about 1,200 square miles underlaid with thick beds of salt, sufficient in amount to supply the world for millions of years; but nearly the whole of this tract of land, with its timber and minerals, was sold to settlers a quarter of a century before the first discovery of salt within its limits. In the eastern counties within the last four years a discovery of corundum was made which has been proved by exploration conducted under Government auspices to have an extent of four hundred square miles. In this instance, however, the lands are mostly in homestead districts, where the minerals are held as the property of the Crown, and they are disposed of under conditions which call for development and the erection and maintenance of works in the Province to manufacture the various products of the ore. But in all its main features the Mines law of Ontario owes its origin and evolution to circumstances connected with the discoveries of minerals in the northern districts—in the territory popularly known as New Ontario.

It is not the purpose of this paper to deal with the subject historically, for this would occupy too much time. It must suffice to describe the law as it is, merely promising that like most other laws, it is a product of experiment, and that no "Finality John" has had part in the shaping of it.

The law is known by its short title as "The Mines Act," and among its first provisions are sections which abolish all royalties upon ores and minerals, and that rescind and make void all reservations of mines, ores and minerals contained in any patent, except patents issued for agricultural lands under the public lands act or the free grants and homestead acts.

Any person, citizen or foreigner, may explore for mines or minerals on any Crown lands, whether surveyed or unsurveyed, except such as may have been withdrawn from sale, location or exploration as being valuable for their pine timber or for any other reason, and any person attempting to explore, occupy or work any lands so withdrawn is liable to a penalty. The main object of this provision is to protect areas which have been sold as timber limits, where the pine is liable to be destroyed by the carelessness of prospectors in building camp fires. Sections which are shown to be rich in ores or minerals may also be withdrawn from sale or lease, pending a careful exploration under the direction of the Commissioner of Crown lands, and the price of lands in a section so proven to be valuable may be fixed at any greater sum than the Act provides, or the lands may be offered for sale at public auction on such terms and conditions as may be fixed by Order in Council.

* Read before the International Mining Congress, June 1900.

When Crown lands are situated within a mining division, and are held and worked under miners' licenses, they are known as mining claims; but when they are situated elsewhere, and are supposed to contain ores or minerals, they may be held or leased as mining lands in blocks or lots called mining locations.

In unsurveyed territory a mining location is required to be rectangular in shape, with the bearings of the outlines due north and south and east and west astronomically, with an area of not less than forty acres, and sides of 20 chains, or with areas which are multiples of forty acres, as 80, 160, 320. In surveyed townships a location may be a fractional part of a lot or section, but so that its area shall be not less than forty acres; and, where road allowances have not been laid out, a reservation of five per cent. of the land is made in the patent, and the Crown or its officers may lay out roads where deemed necessary.

In unsurveyed territory mining locations are required to be surveyed by a licensed surveyor at the cost of the applicants, and to be connected with some known point in previous surveys, or with some other known point or boundary so that the tract may be laid down on the office maps of the territory. The surveyor's plan, field notes and description must be furnished to the Department of Crown Lands within four months of the time of application for the lands, and they will not be regarded as constituting a claim to the location on behalf of the party at whose instance they have been prepared unless they are filed in the department immediately upon completion of the survey. The applicant is required in addition to furnish evidence of the discovery of valuable ore or mineral in the land, as well as evidence of no adverse claim by reason of prior discovery or occupation as far as known to him, and to pay one-fourth of the purchase price or first year's rental within sixty days, and the balance within three months from the date on which his application was filed in the department. The area which any person may acquire in one calendar year of lands containing ores of the same class or kind is limited to 320 acres within a radius of fifteen miles in any one district or county, which may be composed of separate locations of not less than forty acres each; and no firm, syndicate, or incorporated company may acquire more than 640 acres in one year. For every distinct kind of ore discovered within the radius of fifteen miles, the maximum area of land may be taken up in the same year; and so with any discoveries made outside of the radius of fifteen miles. But in case a prospector does not see fit to incur the expense of making a survey of a location and paying the price thereof before he has had an opportunity of proving its value, he may procure from the Commissioner of Crown Lands a miner's license, which will authorize him to stake out and work two mining locations in unsurveyed territory within a radius of fifteen miles, and hold them for a period of two years subject to an expenditure of three dollars per acre in the first year and seven dollars per acre in the second year for actual mining work. If then satisfied that the land is valuable, he may proceed to acquire it in the regular way. In the case of a prospector who is the first discoverer of valuable metals, ores or minerals upon a vein, lode or deposit not less than five miles from the nearest known occurrence of the same kind of metal, ore or mineral, he is entitled to a free grant of one location of forty acres.

Mining lands may be acquired in fee simple upon payment of the price fixed in the Act, or may be taken up under lease tenure subject to the payment of a yearly rental. Both price and rent are regulated by distance from a railway. If a location is in surveyed territory, the price is \$3.50 per acre when within six miles of a railway, \$3 if within twelve miles, and \$2.50 if more than twelve miles from a railway; and prices are 50 cents per acre less in each case if the location is in unsurveyed territory. The rent charge is uniformly \$1 per acre for the first year, 30 cents per acre in subsequent years if the location is within six miles of a railway in surveyed lands, 25 cents if within twelve miles, and 20 cents if more than twelve miles, with a reduction of five cents per acre in each case if the location is in unsurveyed territory. At the end of ten years, if the rent has been paid and the necessary working conditions have been performed, the lessee is entitled to receive a patent for his location free from all conditions, or he may obtain a patent at any time during the demised term upon payment of rent for the full period and performance of all the covenants and conditions of the lease. In practice the lease system provides an easy term of payment, as the aggregate amount at the end of ten years is a mere trifle more than the cash price for a patent. But whether acquired in fee simple or under a lease, a location is held subject to an expenditure for actual mining operations of a sum not less than \$6 per acre during the first seven years immediately following the issue of the patent or lease, whereof \$1 per acre must be expended in the first two years and \$1 per acre in each of the following five years; and if two or more locations are contiguous, the whole of the mining work may be done upon one of them. In default of such expenditure all rights of an owner or lessee are liable to forfeit, and the land is subject to

reversion to the Crown. In the case of lands valuable for iron ore, and where it is reported by an inspector or other officer that a mine may be profitably worked, the owner or lessee may be required to raise 2,000 tons a year for period of ten years, or 20,000 tons in a shorter period of time when the location is not more than forty acres, and a proportional amount if it is more than forty acres, with liability to forfeit of title if this requirement is not complied with. Failure to pay yearly rent subjects a lease to forfeiture, with reversion of the land to the Crown; but in case of co-lessee or co-owner who defaults in rent or performance of working conditions, his interests may be vested in his co-lessees or co-owners who have paid the rent or made the expenditure for working conditions, when delinquency is proven to the satisfaction of the Commissioner.

Pine trees on lands sold as mining locations are reserved to the Crown in the patent, and any person holding a license to cut timber or saw logs on such lands may at all times enter upon the lands and cut and remove such trees, and make all necessary roads for that purpose. The patentee, however, may cut and use trees necessary for building, fencing and fuel on the land, or for any purpose essential to the working of the mines, and may also cut and dispose of all trees required to be removed in clearing the land for cultivation. All pine trees cut on a location except for these purposes are subject to the payment of the same dues as are at the time payable by the holders of licenses to cut timber or saw logs. If a location is held under lease, and in case it is intended to clear any portion of the land for cultivation, the lessee is required to give the holder of the timber license three months' notice, and if at the expiry of that time the timber has not been cut and removed by the holder of the license the lessee may cut and dispose of it, subject to the payment of the same dues as are at the time payable by the holder of the license. Timber other than pine upon a leased location may be cut for building, fencing and fuel, or in the course of clearing for cultivation, or for any purpose essential to the working of the mines; but none shall be cut for any other purpose except with the authority of the Commissioner, and subject to the payment of dues at a rate to be fixed by the Commissioner.

When the surface rights have been granted for agricultural purposes the mining rights may be acquired by a prospector who is the discoverer of ore or mineral thereon at one-half the price or rental of mining lands, subject to compensation for injury or damage to the surface right; and in case the owners of the surface and mining rights cannot agree, the Director of the Bureau of Mines may prescribe the manner in which compensation shall be ascertained and paid or secured.

Whenever the Government of Province sees fit, it may by order in Council set apart any tract of country described in the order as a mining division, and may from time to time add to, diminish or cancel the division by an order. Lands held for mining purposes in such a tract are known as mining claims, and the tenure is one of occupation by any person, partnership or mining company holding a miner's license. Licenses are granted for one year on payment of a fee of \$10, and are renewable from year to year. They authorize the licensee to explore any portion of the mining division, and to mine on any claim marked or staked out by themselves on Crown lands; but any person may be employed by a licensee to work his claim, or he may organize a company to work it, or may transfer it to another licensee. Discovery of a vein, lode or other deposit of ore is prerequisite to the staking out of the claim, and it is deemed to be staked when a discovery post is planted upon an outcropping of ore or mineral in place within the boundaries of the claim, and a stake is planted at each of the four corners, numbered in order from the northeast to the northwest corner. A claim may be a square of fifteen chains, containing 22½ acres, or of any other extent greater or less as may be fixed by regulation, but so as not to exceed a square of 20 chains containing forty acres, and the ground included in each claim is deemed to be bounded under the surface by lines vertical to the horizon. A licensee who has staked out a claim is required within thirty days to register it with the Inspector for the Division by filing under oath an outline sketch of the plan, showing the discovery post and corner posts and their distances from each other, together with a notice in writing setting forth the name of a licensee, the locality of the claim as indicated by some general description, the time when it was marked out, the length of the boundary lines if for any cause they are not regular, the situation of the discovery post and the date of the record; and the Inspector is required forthwith to enter the particulars of the notice in his book, and file the notice and sketch or plan of the claim with the records of his office. If the licensee fails to comply with the requirements for registration, or if having complied with them he or any person on his behalf removes any post for the purpose of changing the boundaries, after the plan and notice have been filed, the claim shall be deemed to be forfeited and all the rights of the licensee in it shall cease. A claim may also be forfeited if the

miner's license has run out and has not been renewed, or if the annual fee has not been prepaid in the case of a licensee who is the holder of more than one claim, or if a sum of \$150 has not been expended upon it in actual mining work. No more than one claim may be staked out upon the same vein, lode or deposit of ore by an individual licensee, unless it is distant at least sixty chains from the nearest known mine, claim or discovery on the same vein or lode; but no licensee may stake out and record in the same mining division more than four claims in one calendar year within a radius of fifteen miles, and for each additional claim after the first a fee of \$10 is required. A licensee who is a holder of five claims or less within a radius of one mile may carry on all mining operations demanded by the Act upon one of them, or different persons holding claims within a radius of one mile may combine to expend all of their operations on one claim for every five claims or less.

When the working conditions have been complied with for a period of four years on a claim of 20 chains square, or for three years on a claim of fifteen chains square or less, or when an equivalent of such working conditions has been complied with in a less period of time, the licensee may apply for and obtain a certificate of full performance of working conditions for the claim free from any further working conditions, renewal fee or miner's license. He may also, if he desires to hold the claim under a patent or lease, proceed to get a survey made of it as a mining location, and pay in the purchase money or first year's rent at the rates fixed by the act for mining locations. This provision, however, is not for the sake of securing a better title, but to satisfy a desire for better description by metes and bounds, a holding under the great seal, and the right to record in the office of the Register of Titles.

Other provisions of the Mines Act relate to mining regulations for the health and safety of men employed in mines and mining works, and for the punishment of offenses against the act. There are also provisions for administration under the office of the Bureau of Mines, which was organized to aid in promoting the mining interests of the Province. The inspection of mines, the conduct of exploratory work under direction of competent geologists, the operation of diamond drills and the encouragement of iron mining by the payment of a bonus to miners for ores smelted in the Province, are all within the sphere of the Bureau's operations.

During the present season ten exploration parties have been organized to make a careful examination and report on the northern regions of the Province. This territory extends from the Quebec boundary on the east to the Manitoba boundary on the west, a length of 700 miles, and its area is about 90,000 square miles, or about 40 per cent. of the whole Province. It is one and a half times larger than the whole State of Wisconsin, and nearly twice as large as the Orange Free State, but excepting along the lines of its canoeable waters it is as little known as the Congo Free State in the heart of Africa. Almost certainly it is a region in which there are great forests of spruce and other kind of trees, valuable for pulp wood; there are wide tracts of clay loam deposited in ancient lake bottoms, as well as large areas of till, both of which are calculated to form the best of farm land; and there are many thousands of square miles of the Archaean formations in which the trained prospector would have every reason to expect to find rich stores of ores and minerals.

I have kept for the close of my paper reference to a new provision of our Mines Act, which, however, has not yet been brought into operation. Its purpose is to secure to Ontario a larger share of an industry which in recent years has been built up out of raw materials which the Province possesses in large abundance, namely the refining of nickel and the production of nickel steel. Two works with ample capital are in course of construction for the production of steel, the refining of nickel and the manufacture of nickel steel, and one if not both of them includes in its scheme a plant for the making of nickel-steel rails for railways, at a cost estimated to exceed but a little the cost of Bessemer rails. For this industry Ontario is well favored by its supplies of the raw materials, and, if deemed necessary for the object in view, effect will be given to the provision of the law when the works are equipped and practically established. Stated in its briefest terms, the provision requires that every person carrying on the business of mining nickel ore in the Province shall pay to the Treasurer of the Province a license fee computed at or below a fixed maximum rate upon the gross quantity of ore raised or won by him during the preceding year, with a right to remission if the ore has been treated in the country so as to yield fine metal, or other form or product of the ore suitable for direct use in the arts without further treatment. But it is provided that until it is brought into force by proclamation of the Lieutenant-Governor in Council, this provision shall not take effect.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Many of the questions given by the several State Boards of Examiners suggest principles which can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question, which should be as brief and concise as possible. It is the purpose of MINES AND MINERALS, to discuss in this department of "Examination Questions" the principles of practical mining upon which these questions are based, feeling sure that such articles will be appreciated by and be a help to all who are preparing themselves for mine examinations.

Mine Inspectors' Examination for the Sixth Anthracite District of Pennsylvania, Held at Pottsville, Pa., May 8, 1900.

Applicants were allowed from 10 A. M. to 5 P. M., to answer the following questions, constituting the written examination of applicants for the office of Mine Inspector. In addition to the written examination, each applicant was required to pass a subsequent oral examination before they could be recommended by the Examining Board to the Governor for appointment to the office of Mine Inspector.

(a) Name? (b) Age? (c) Are you a citizen of Pennsylvania, and have you been practically connected with the Anthracite mines of Pennsylvania for a period of five years?

QUES. 1.—Give the name and location of the mines in which you have been employed, and the nature of your employment and the length of time you were so employed at each.

QUES. 2.—State what you believe to be the duties of an Inspector of Mines, and show how his time ought to be divided in order to properly perform each of the several duties.

ANS.—This question is fully answered in reply to Ques. 1, page 85, MINES AND MINERALS, September, 1899. See also, answer to Ques. 1, Oral Examination For Mine Inspectors, Iowa, page 86, MINES AND MINERALS, September, 1900.

QUES. 3.—Write a brief but complete description—including the inside and outside improvements, sizes of breaker, hoisting engines, boilers, wire rope, pumps, etc.—of any large colliery with which you are familiar.

ANS.—This question is answered in reply to Ques. 6, page 86, MINES AND MINERALS, September, 1899.

QUES. 4.—Name the gases commonly found in coal mines. Describe each fully.

ANS.—This question is fully answered in reply to Ques. 3, page 85, MINES AND MINERALS, September, 1899. See also, answer to Ques. 9, page 329, MINES AND MINERALS, February, 1900; also answer to Ques. 4, page 428, April, 1900.

QUES. 5.—Describe the several methods of timbering shafts, slopes, gangways, chutes, and headings. State the advantages of each method, and under what conditions of strata you would apply them.

ANS.—*Shafts.*—In firm rock strata little timbering is required, in shaft sinking. Cross buntings of pine, hemlock, or oak (usually, 6" by 8") are employed. These buntings are spaced about six feet apart, and set in hitches cut in the rock. They are firmly wedged in line, from the top to the bottom of the shaft. The buntings furnish a support for the guides, and for the pipes and signal wires required in the shaft, as well as for the partition separating the hoist way from the man or pumpway. In *frail* or *loose material*, shaft lining or curbing is required. The curbing is usually continuous from top to bottom, but at times curbing is only used where the strata require support. (See article "Methods of Shaft Timbering," page 138.)

Slopes, Gangways, and Headings.—The timbering of slopes, gangways, and headings, is fully described in answer to Ques. 39, page 274, MINES AND MINERALS, January, 1900.

Chutes.—The timbering of chutes is very similar to the timbering of slopes, referred to in the previous paragraph. The timbers are usually shorter, and are often set closer together; although this depends very much upon the character of the roof and floor and the permanency of the chute. Where the floor of the chute is laid with iron, cross timbers are introduced to give support to

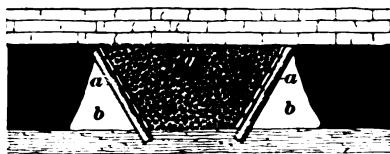


FIG. 1.

the iron. A line of posts is usually set on one or both sides of the breast, a short distance from the rib, to form the manways *b, b*, Figs. 1 and 2. Sheathing planks are spiked to the inside face of the posts to form the sides of the chute. In some cases the

timbers or posts (*a, a*, Fig. 1), dividing the manway from the chutes are inclined so as to lean against the rib, forming a triangular shaped passageway; such timbers are known as "juglars." These two forms of setting the timbers are shown in Figs. 1 and 2.

QUES. 6.—Describe all the methods used in mining anthracite coal with which you are familiar, and state the varying conditions which make one preferable to another.

ANS.—The methods usually employed in the mining of anthracite coal are the room and pillar, often called the *bord* and pillar, or the pillar and chamber method; the pillar and stall method, and the panel system of mining. In some localities where the cover is not great, the method by stripping is employed. The longwall system of mining has not been successfully employed in anthracite workings, except to a very limited extent. These several systems of working coal are fully described in the article "Systems of Working Coal," page 245, MINES AND MINERALS, January, 1899, and page 292, February, 1899. See also answer to Ques. 5, page 85, MINES AND MINERALS, September, 1899, and also MINES AND MINERALS, March, 1898, page 337.

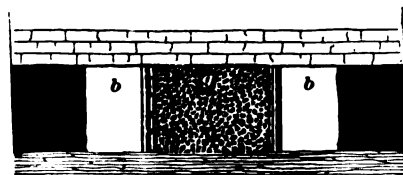


FIG. 2.

QUES. 7.—State the advantages, if any, of hoisting water in tanks over the usual method of pumping from deep mines.

ANS.—The advantages claimed for hoisting water in tanks as compared with the usual method of pumping are that more water can be handled at less expense by the former method. Also, the difficulties encountered when pumps are employed, in respect to the corrosion of the pump linings and valves by the sulphurous water of the mine, are eliminated, and the annoyance of pipe lines in the shaft and of exhaust steam at the bottom of the shaft, and the necessary attendance upon the pumps are also avoided when tanks are used.

QUES. 8.—Mention the explosives commonly used in mines. Describe their properties and peculiar characteristics, and show their adaptation for certain results in blasting operations.

ANS.—This question is fully answered in reply to Ques. 13, page 139, MINES AND MINERALS, October, 1899.

QUES. 9.—Describe the several systems of extinguishing underground mine fires, and state the conditions under which each could be advantageously used. Give your experience in this branch of work.

ANS.—This question is fully answered in reply to Ques. 8, page 86, MINES AND MINERALS, September, 1899.

QUES. 10.—In a gangway driven in a coal seam ten (10) feet thick, with a bad top and heaving bottom, forty (40) breasts have

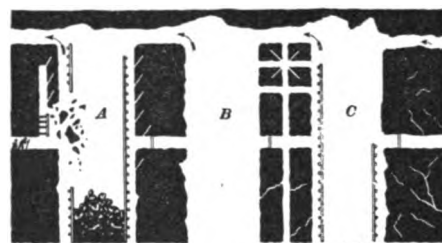


FIG. 3.

been worked up a distance of sixty (60) yards, at an angle of sixty degrees, and are standing full of coal, the breasts and pillars are eight (8) yards wide. State how you would proceed to remove the coal and rob the pillars.

ANS.—It is important in this case to keep a manway always open for the escape of the men. The coal in the chutes should not be drawn faster than the work upon the pillars progresses. The safest method to pursue would be to drive a narrow heading up the center of each pillar, which will furnish the escape for the men. Cross-cuts are driven at intervals of say 8 or 10 yards, dividing the pillar into sections; each section of pillar being worked to the rise from these cross-cuts. If the conditions will permit, the pillars may be worked from the upper end downward, the coal being chuted across the manway into the breasts upon either side; but this is not usually practicable. The coal in the breasts is drawn, only as the work progresses. If the pillars are worked from above, cross-cuts will not be required in the pillars, but care will be necessary to keep the manway open for escape. Fig. 3 illustrates some of the methods employed in drawing pillars in steep seams.

QUES. 11.—Describe the precautionary measures you would

adopt to prevent accidents where your gangways were approaching an abandoned mine filled with water.

Ans.—This question is answered in reply to Question 13, page 427, MINES AND MINERALS, April, 1900. See also article, "Precautions Necessary When Mine Entries Are Approaching Abandoned Workings," page 236, MINES AND MINERALS, December, 1899.

Ques. 12.—Make a classification of the accidents occurring in anthracite mines, and state how, in your judgment, they may be diminished.

Ans.—The accidents occurring in anthracite mines are classed under the following general heads, which we give in the order of their relative importance. (1) Accidents from falls of roof or coal. (2) Accidents in connection with the movement of mine cars, machinery, etc. (3) Accidents in connection with blasting, handling of powder, etc. (4) Accidents in connection with mine gases. (5) Accidents in connection with shafts or steep inclines. (6) Miscellaneous. The number of accidents occurring in mines, as classified above, may be very greatly diminished by a strict enforcement of the mining laws. The management and the mine foreman should not only give orders in accordance with the several requirements of the mining laws, but should see that their orders in this respect are carried out. The neglect due to this is the direct cause of a very large number of avoidable accidents. From 40 to 50 per cent. of all accidents in mines are due to falls of roof and these are very largely the result of negligence or carelessness on the part of miners themselves and lack of proper oversight by the management.

Ques. 13.—It is required to raise 800 loaded mine cars daily, in a two-compartment shaft 400 yards deep. Give the general dimensions of the engine, drum, diameter of rope, etc., necessary to properly perform this work, assuming the weight of the load to be $3\frac{1}{2}$ tons, the weight of the car $1\frac{1}{2}$ tons, the weight of cage $1\frac{1}{2}$ tons, and the steam pressure 90 pounds per square inch.

Ans.—Following is the load upon the rope:

Coal	$3\frac{1}{2}$ tons =	6,500 lb.
Car	$1\frac{1}{2}$ tons =	3,000 lb.
Cage	$1\frac{1}{2}$ tons =	2,500 lb.
1" Rope		1,900 lb.
Total		13,900 lb.

Size of Rope.—The gross load or the entire moving load includes the weight of two cars, two cages, one rope, and one load of coal, making a total of 19,400 lb. Assuming the friction of winding to be $\frac{1}{10}$ of the gross load, we have for friction, say 2,000 pounds, which added to the net load gives a total load upon the rope of, say 16,000 pounds. The proper working load for a one-inch plough steel rope is 10 tons. As the working load of a $\frac{7}{8}$ -inch steel rope is $8\frac{1}{2}$ tons, we could use, in this case, such a rope; but on account of the importance of the hoisting rope and the wear to which it is subjected, we prefer to use the one-inch rope, in this instance.

Speed of Hoisting.—Assuming that 800 hoists are made in 10 hours the time of hoisting is obtained as follows:

$$\frac{10 \times 60 \times 60}{800} = 45 \text{ seconds,}$$

for each hoist, including the time required for changing cars, and starting and stopping each trip. Assuming a speed of hoist of 40 feet per second, we have for the actual time of hoisting each load $\frac{1,200}{40} = 30$ seconds. This gives $45 - 30 = 15$ seconds for change of cars, etc.

Speed of hoisting, $40 \times 60 = 2,400$ feet per minute.

Diameter of Drum.—Assuming a direct acting, duplex engine making say, 150 strokes per minute, which gives 75 revolutions of the drum per minute, we have for the diameter of the drum,

$$d = \frac{2,400}{3.1416 \times 75} = 9.96, \text{ say } 10 \text{ ft.}$$

Mean Effective Cylinder Pressure.—Assuming the engine cuts off at $\frac{2}{3}$ stroke, we may calculate the mean effective cylinder pressure from the given boiler pressure (90 lb.), by using the formula,

M. E. P. = $.9[.917(90 + 14.7) - 17] = 71.1$ lb. per sq. in. See "Calculation of Size of a Winding Engine," page 379, MINES AND MINERALS, March, 1900.

Load Upon the Engine.—Assuming that the weight of the car and cage is balanced, since this is a two-compartment shaft, we have for the load upon the engine as follows:

Coal	6,500 lb.
1" Rope	1,900 lb.
Friction	2,000 lb.
Total	10,400 lb.

$$\text{Horsepower, } \frac{10,400 \times 2,400}{33,000} = \text{say } 750 \text{ horsepower.}$$

Size of Engine.—Assuming the ratio of length of stroke to

diameter of the cylinder as 1.4 and the efficiency of the engine as 60%, we have for the diameter of the cylinder,

$$d = \sqrt[3]{\frac{u}{.7854 p r n}} = \sqrt[3]{\frac{750 \times 33,000}{.60 \times .7854 \times 71.1 \times 1.4 \times 150}} = 14 \text{ in.}$$

See page 569, MINES AND MINERALS, July, 1900.

For the length of stroke we have $14 \times 1.4 = \text{say } 20$ inches. The size of engine required for this hoist is therefore $14'' \times 20''$.

Ques. 14.—Describe the instruments used in determining the character and condition of the atmosphere of a mine, and explain how they are used in making such tests.

Ans.—Art. 2, Sec. 6, of the Anthracite Mine Law requires that the Mine Inspector shall provide himself with "The most modern instruments and appliances." He will therefore need the following instruments: watch, anemometer, watergauge, barometer and thermometer. Of these the three first named instruments are important in determining the quantity of air in circulation in the mine, and the ventilating pressure. The last two instruments named are used more particularly in determining the character and condition of the mine air in circulation with respect to pressure and temperature. Another machine known as the Shaw gas tester has been introduced at many of the larger mines, for determining the percentage of gas in the air-current. These instruments and their uses have been previously described. See answer to Ques. 4, page 85, MINES AND MINERALS, September, 1899; Ques. 30, page 273, January, 1900, and Ques. 5, page 86, September, 1900.

Ques. 15.—Describe briefly the geological structure of the Western Middle Anthracite Coal field, comprised within the Sixth Inspection District, giving the names and average thicknesses of the coal beds and the thickness and character of intervening strata.

Ans.—The geological structure of the Western Middle Anthracite Coal field consists of a series of coal beds of varying thickness separated by intervening strata of soft slates, bituminous shales and sandstones. Beginning at the bottom the names of the several coal beds with their average thickness are as follows: Buck Mountain, averaging between 6 and 20 feet in thickness; Seven Foot, averaging from 3 to 7 or 8 feet in thickness; Skidmore, from $2\frac{1}{2}$ to 6 or 8 feet in thickness; Mammoth (sometimes in two or more splits), averaging from 20 to 50 feet where the splits are all joined together; Holmes, from 6 to 10 feet; Four Foot (often considered a split of the Holmes), from 3 to 6 feet; Orchard, from 3 to 7 or 8 feet, and Diamond, from 3 to 10 feet in thickness. The character of the intervening slates, shales and sandstones is usually soft, but the cover rock of the Buck Mountain seam is an extremely hard sandstone.

Ques. 16.—Describe fully the system of ventilation used in any large colliery, giving the sizes of fan and engine, the volume of air circulating, and the number of men employed in the mine.

[In answering this question each applicant would select the colliery with which he was most familiar and describe briefly the system of ventilation employed, stating the sizes of the fan and engine, volume of air passing in the mine, and the number of men employed.]

Ques. 17.—Explain how you would proceed to determine the efficiency of a ventilating fan.

Ans.—To calculate the manometrical efficiency of a ventilating fan, the theoretical water gauge due to the fan's action is first obtained from the formula

$$I = \frac{v^3}{g \cdot 5.2}$$

In which I = the theoretical water gauge (in.); v = velocity of blade tips (ft. per sec.); g = force of gravity (32.16); w = weight of one cubic foot of air (.0766 lb., temp. 60° F., bar. 30"). The efficiency is then determined from the formula

$$K = \frac{i}{I} \times 100,$$

in which K = efficiency of the ventilator; i = actual water gauge (in.).

For example, to find the efficiency of a ventilating fan, 20 feet in diameter, making 70 revolutions per minute, and giving a water gauge of 2 inches, we have

$$I = \left(\frac{3.1416 \times 20 \times 70}{60} \right)^2 \times \frac{.0766}{32.16 \times 5.2} = 2.461 \text{ in.}$$

$$\text{Then, } K = \frac{2}{2.461} \times 100 = 81.27 \text{ per cent.}$$

If it is desired to find the mechanical efficiency (ratio between the effective and theoretical work performed), the usual practice is to take a card from the engine running the fan and calculate therefrom the power employed, and then divide the effective work (qp) in the fan drift by the power employed and multiply the quotient obtained by 100. The result is the percentage of efficiency. This method is faulty, however, inasmuch as it embraces in the efficiency of the fan, that of the engine

and does not present therefore a correct basis of comparison. See article "Determining the Efficiency of a Ventilating Fan," page 137.

Ques. 18.—The volume of air passing through a semi-circular arched tunnel of four (4) feet radius, springing four (4) feet above the floor, is 23,625 cubic feet per minute, what is the velocity per minute?

Ans.—The area of this airway is obtained as follows (See Fig. 4):

$$4 \times 8 + \frac{.7854 \times 8^2}{2} = 57.13 \text{ sq. ft.}$$

Then, to find the velocity, we have $\frac{23,625}{57.13} = 413.5 \text{ ft. per min.}$

Ques. 19.—Under the usual existing conditions, what sized breast pillars would you recommend in mining the Mammoth coal seam, forty (40) feet thick, on the fourth (4th) level, in the Mahanoy Valley?

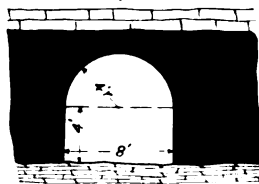


FIG. 4.

Ans.—This question is to some extent an open one, calling for opinions as guided by experience in different workings of this seam. Under ordinarily good conditions it has been found safe in driving an advance breast in this seam to make the width of the opening 30 feet, and to leave a 40-foot pillar between the openings.

Ques. 20.—State your experience, if any, with electricity applied for both light and power, in coal mining operations; explain its advantages and disadvantages.

Ans.—Among the troublesome features in regard to the application of electricity to mining operations, may be mentioned the following: (1) Incandescence of the conducting wire. (2) Sparking occurring in the motor or caused by a broken circuit. (3) The producing of a voltaic arc between two carbon terminals.

Extensive experiments conducted in Germany in 1897 show the following results:

Incandescent Lamps.—Naked films raised to high incandescence may or may not cause the explosion of firedamp. The breaking of the lamp bulb and the film was usually accompanied by bad sparking which sometimes produced an explosion of the firedamp and sometimes not. In some cases, the filaments remained intact, when the bulb was broken; and in such cases, also explosions sometimes took place and sometimes not. These experiments seemed to indicate that the amperage was the chief element to be considered. Continuous or alternating currents of less than 0.6 ampere did not produce ignition, although sparking often occurred. Stronger currents than this usually caused ignition. The following recommendations are made: Use stout globes with round bulbs, to prevent cracking from water dripping on the hot bulb. Protect bulbs by wire cages. Use low current lamps (0.6 ampere maximum) and high voltage, but not above 150 volts; as excessive volts are dangerous. Do not use lamps with two filaments in series, in order to avoid danger of sparking. Locate leading-in wires far apart, to avoid their being bent together and making a short circuit.

Arc Lamps.—The arc lamp did not ignite coal dust, even in an atmosphere containing 4% of marsh gas; but in 6% of marsh gas explosions took place whether the lamp was already burning or was switched in. Arc lamps, should therefore be condemned for use in coal mines.

Switches, Wires, Etc.—Switches for one or more lamps are dangerous, on account of their tendency to cause sparking. Glowing wires do not cause explosion, although melting wires, especially copper, may ignite the gas; but an iron wire buried in coal dust and heated by the current until it arched strongly did not ignite the coal dust either when it was quiet or when it was stirred into a cloud. Fusing wires protected by a shunt may be considered harmless, but ordinary safety fuses of lead and tin are to be condemned.

Electric Motors.—Large size motors are safer than smaller types, because variations in the load affect them less. Carbon brushes spark less and are therefore to be preferred. In an experiment, a motor placed in a box under a fine wire gauze cover, set fire to the explosive mixture in the box, on starting; but the flame did not strike through the gauze. It is recommended that the motor should be incased in a wire gauze netting and double brushes used. In general, continuous-current motors, switches, fuses, etc. should be avoided, and should be incased wherever they are put up.

French experiments have since corroborated the German experiments mentioned above, and seem to show that an incandescent wire has no power to produce an explosion, except by contact, so long as the wire remains unbroken; but contact with another wire or conductor generally produces an explosion of the firedamp.

Advantages of Electricity in Mining.—Among the advantages of electricity as applied to mining may be mentioned the following: (1) The cost of generation is low. (2) The current is easily conducted to any point of the mine workings; conducting wire is cheap, in comparison with the requirements of other systems. (3) The system is pliable and well adapted to the changing conditions in mine workings. (4) There is less power lost in transmission than in any other system that can be adopted. (5) Electrical apparatus is readily installed. (6) The system not only furnishes power for motor haulage, but also light and power, in the mine workings.

Ques. 21.—A fan attached to the workings of a coal seam eight (8) feet thick, running at the rate of forty (40) revolutions per minute, shows an inch of water gauge. What will be the probable water gauge if the speed of the fan be doubled?

Ans.—The usual rule with respect to the yield and pressure due to a fan, is that the quantity varies as the speed of the fan and the pressure as the square of the speed. According to this rule, if the speed of the fan be doubled the water gauge will be multiplied four times, giving four inches of water gauge in this case. Practically, however, the water gauge obtained will be slightly more than 3 inches. See answer to Ques. 6, page 41, MINES AND MINERALS, August, 1900.

Ques. 22.—Find the area and perimeter of an ellipse whose axes are five (5) feet and ten (10) feet respectively.

Ans.—Area = $.7854 \times 5 \times 10 = 39.27 \text{ sq. ft.}$

$$\text{Perimeter} = 3.1416 \times \frac{5+10}{2} = 23.562 \text{ ft.}$$

Ques. 23.—Explain how you would determine the safe working load for a seasoned hemlock mine prop ten (10) inches square and ten (10) feet long, assuming that the crushing load per square inch is 5,300 pounds.

Ans.—The safe working load in this case is best calculated by the use of what is known as Gordon's formula.

$$P = \frac{fA}{1 + c\left(\frac{l}{d}\right)^2},$$

in which P = the crushing load upon the prop (tons); f = crushing strength of the material (tons per sq. in.); A = smallest area of cross section (sq. in.); c = constant depending upon the material and whether fixed at both ends (for hemlock squared ends $c = .004$); l = length of prop (in.); d = least diameter or thickness (in.). Substituting in this formula the given values, we have

$$P = \frac{2.65 \times 10 \times 10}{1 + .004\left(\frac{10 \times 12}{10}\right)^2} = 168 \text{ tons.}$$

Then using a factor of safety of 4, we have $\frac{168}{4} = 42 \text{ tons, safe load.}$

(See page 77, "The Coal and Metal Miners' Pocket Book.")

Ques. 24.—If a gangway collar six (6) feet long and eight (8) inches in diameter be required to sustain a certain weight, what thickness of collar would be required to sustain a similar weight on a turnout twelve (12) feet wide?

Ans.—Assuming the span of the collar to be 6 feet, in the first case, and 12 feet in the second case; and the cross-section of the collar to be a circle; and since, for the same load, the length of the span varies directly as the cube of the depth of the collar, for beams of circular cross-section; the collar of 12 feet span would require to be $8 \times \sqrt[3]{2} = 8 \times 1.26$, or say 10 inches deep, to support the same load as supported by a collar 8 inches deep having a span 6 feet long.

Examination of Mine Foremen and Hoisting Engineers, Under the New Law in Iowa.

The first examination under the law requiring mine foremen and hoisting engineers to possess certificates of competency was held at Albia, Iowa, beginning August 6th and lasting four days. The schedule called for other examinations to be held each alternate week as follows: Des Moines, beginning Aug. 20, 1900; Oskaloosa, beginning Sept. 3, 1900; Centerville, beginning Sept. 17, 1900; Boone, beginning Oct. 1, 1900. A great interest is being manifested. In the published lists of those taking the examination we notice the names of many who are not holding the positions for which they wish to qualify. This shows a laudable ambition, and argues a healthy, intelligent condition of the miners, as a class, in Iowa. While it cannot but be expected that the operation of the new law will debar some who are now serving as foremen or engineers from holding such positions in the future, yet these vacancies will be quickly filled by those who should in time make more intelligent, practical and useful officials. In this way the purpose of the law is subserved, the

safety of the ten thousand miners in the state is more assured; and in every way the industry of mining is elevated.

At Albion, 43 engineers and upwards of 50 foremen presented themselves for examination, of whom we are glad to say only a very few failed to secure the coveted certificate. Service certificates were also granted by the Examining Board to a large number who produced the "satisfactory evidence" of having performed their respective duties as mine foremen or hoisting engineers for the four years immediately preceding the date of the new law's going into effect, January 1, 1901.

One salutatory effect already observed in this forward march of intelligence is the desire it at once awakens in the mind of all for practical, common sense reading in matters pertaining to mining. And what is true in this respect of the mining industry, is equally true of all trades and professions. It is common to miners, mechanics, and other tradesmen, while they recognize the growing need of knowledge, to postpone its attainment until such knowledge is made obligatory by such a law as passed the Iowa legislature last March.

False Water-Gauge Readings.

The point at which the water gauge reading is taken has a very important bearing upon the results of a fan test. We are accustomed to say that the quantity of air in circulation varies as the square root of the pressure, for the same airway, which means that four times the pressure will produce double the quantity of air in a given airway. We accept this law as a fundamental law of ventilation. It accords with reason, since when twice the quantity of air is passing, in the airway, in a given time, each particle of air moves twice as fast, or meets with twice the number of resisting particles, and strikes each of those resisting particles with twice the force, and from this we conclude that the resistance or pressure head is made $2 \times 2 = 4$ times the original resistance. All fundamental formulas in ventilation are based upon this relation between pressure and velocity, or pressure and quantity, giving us the formula

$$p = \frac{k s v^2}{a} = \frac{k s q^2}{a^3}$$

From the latter of these two expressions, we may write

$$\frac{q^2}{p} = \frac{a^3}{k s}$$

For any given airway, we observe that the ratio

$$\frac{q^2}{p}, \text{ or } \frac{q}{\sqrt{p}}$$

is a constant which we call X . This ratio expresses the resisting power of the airway, and we have called this factor the *potential of the airway* with respect to pressure, or the *pressure potential*. For a constant potential, the quantity of air varies as the square root of the pressure.

But having established this law expressing the relation between the quantity and pressure, we must always bear in mind that the pressure referred to here, is the pressure producing circulation. It is often carelessly assumed by observers, in making fan tests, that the water gauge reading wherever taken, represents the ventilating pressure for that circulation. This is often a very bold assumption, and is a prolific source of error, and has at times given rise to statements to the effect that the law to which we have just referred is not correct, under all conditions. The trouble, however, is not with the law, which expresses a fundamental mechanical principle; but arises from the fact that the water gauge reading, in the position in which it is often observed, does not express the pressure producing circulation. Nor is it possible, in all cases, to obtain a water gauge reading that will correctly express the pressure producing ventilation. This may seem strange to us at first, but a little study will make the matter clear, and will give us a more intelligent idea in regard to conditions that are vital in making a fan test.

We have drawn Fig. 1 to represent a sectional elevation of a mine opened by two shafts, a fan shaft and a hoisting shaft. The lower part of the figure is drawn in plan to show the airway and haulage road extending from the bottom of these shafts, respectively. There is also shown the first cross-cut or breakthrough, between the main intake and return entries. The fan may be either an exhaust or a blow-down fan, but as at present arranged it is the latter. There are two places at which it is common to take the reading of the water gauge in making a fan test; and these are designated by the letters S and U , indicating surface and underground readings, respectively. We must bear in mind that a water gauge reading represents always the *difference* between the pressures upon the two arms of the gauge; and it is true that this *difference of pressure* is the ventilating pressure, at that point of the airway. It does not follow, however, as is too often assumed, that there is no other pressure producing ventila-

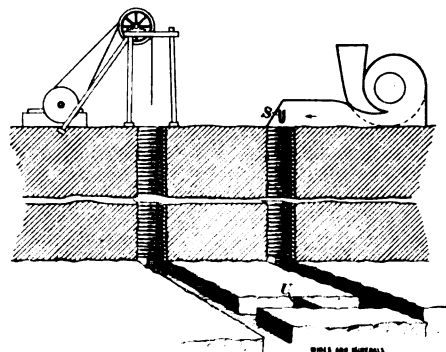
tion. In point of fact, there are numerous causes which affect the ventilating pressure or *head of air-column producing ventilation*, which for convenience we will term the *ventilating head*. Some of these causes are positive in their effect and some are negative. Those that are positive act to assist, while those that are negative retard the circulation. It will be more convenient to refer to these several causes as *positive or negative heads*. They may be stated as follows: (1) Head of air-column in shaft, due to a difference of temperature in the upcast and downcast columns. (2) Head of air-column in rise or dip workings, due to difference of temperature between intake and return currents. (3) Damp heads in upcast shaft, due to presence of mine gases. (4) Damp heads in rise and dip workings. (5) Frictional head.

Of the several heads mentioned in the preceding paragraph it will be observed that some are constant heads, with respect to the quantity of air in circulation; that is to say, they do not vary as the square of the quantity or as the ventilating head. Others vary in the same ratio as the ventilating head, and therefore do not affect the results, as far as the relation between the quantity and pressure in any circulation is concerned. All of the heads mentioned, except the frictional head, are constant heads.

To understand clearly how these several factors affect the observations in a fan test, let us suppose the water gauge reading is taken at S . Denoting the atmospheric head by B , and the head due to the action of the fan by p_1 , the pressures upon the respective arms of the water gauge will be $B + p_1$, and B , and the difference of these pressures will be p_1 , which represents the pressure due to the fan's action. Now, suppose that the shafts are deep and have different temperatures, and call the weights of the downcast and upcast air-columns W_1 and W_2 , respectively. If we take a water gauge reading underground at U , the pressure upon the two arms of the water gauge will be

$$B + p_1 + W_1, \text{ and } B + W_2,$$

and denoting by p_2 the head of air-column in the shaft, we have $p_2 = (W_1 - W_2)$. Then, the ventilating head at U is represented by $p_1 + p_2$. If the temperature of the upcast column is greater than that of the downcast, $p_2 = (W_1 - W_2)$ will be positive, and the ventilating head at this point will be greater than the ventilating head at S . If, however, the upcast column is colder than the downcast, or if a blackdamp column exists in the upcast shaft, $p_2 = (W_1 - W_2)$ will be negative, and the ventilating head at U will be less than the ventilating head at S . In the first case the action of the fan, represented by the water gauge reading at S , is *assisted*, and in the other case *retarded* by the head of air-column in the shaft. In like manner the circulation is assisted or



retarded, as the case may be, by the head of air-column often existing in rise and dip workings in the mine, due to the general inclination of the seam. Also, the circulation is either assisted or retarded, as the case may be, by damp heads or columns of blackdamp existing either in the shaft, or rise or dip workings. The most effective of these damp heads are those due to the existence of a large quantity of blackdamp in the return current, pure carbonic acid gas being somewhat more than half again as heavy as air (specific gravity 1.529). This factor has a very powerful influence in retarding the current in deep shafts or seams of steep inclination and which give off considerable blackdamp. When a large quantity of marsh gas is given off at the face of rise workings, ventilation is likewise retarded to a considerable extent, though not to the same extent as in the former case. Marsh gas given off in considerable quantity at the face of dip workings, or blackdamp in rise workings, operates to assist circulation. All of these heads are constant heads acting to assist or retard the ventilating current. The frictional head referred to always acts to retard circulation, but this head has no effect to change the ratio between the quantity of air in circulation and the pressure producing this quantity, since it varies in a like manner, or as the square of the quantity.

To properly conduct a fan test the water gauge should be

placed at both *S* and *U*. When the fan is stopped momentarily the water gauge at *S* will fall to zero, while the water gauge at *U* will indicate by its reading the influence of any columns that may exist in the shaft either as positive or negative in effect. A few minutes of time should be allowed to elapse, however, before the reading at *U* is taken, in order that conditions may adjust themselves. Whatever columns may exist in the rise and dip workings of the mine should be estimated by taking the average temperature of the intake and return of the airways, and observing their condition with reference to the amount and kinds of gases they contain. This last estimation will necessarily only be approximate. In flat seams or seams of small inclination, inside air-columns may be ignored; but in steep seams, they should always be estimated as closely as possible both with respect to temperature and gaseous condition.

The reading of the water gauge at *S* will express correctly the pressure due to the action of the fan, while the reading at *U* will express correctly the pressure producing ventilation in the mine workings in flat seams or seams of small inclination. In steep seams the reading of the water gauge at *U* must be corrected from the observations explained in the previous paragraph. The reading at *U* for flat seams, or the corrected reading for inclined seams, will vary with the square of the quantity of air in circulation, in accordance with the law that the pressure producing ventilation varies as the square of the quantity of air in circulation. The reading at *S* will not vary according to this law when there is any considerable air-column either positive or negative in the shaft or the workings, since the shaft column is constant for the same atmospheric conditions.

The reading at *S*, however, will vary approximately according to the square of the revolutions of the fan. We say approximately, because the fan has not the same efficiency at all speeds, its efficiency increasing as the speed decreases. The existence of any considerable air columns in the shaft or in the mine will have the effect to vary considerably the efficiency of the fan. For example, where these air columns are positive, assisting ventilation, a larger quantity of air will be drawn through the fan than that due to the fan's action, and as a result a larger proportion of work will be absorbed within the ventilator. On the other hand, the fan will be rendered more efficient seemingly, when the existing air columns are negative, or retard ventilation, since a smaller quantity of air will traverse the fan, a portion of the pressure due to the fan's action being neutralized by these negative columns.

To show the disproportion arising from the constant heads, either positive or negative, existing in shafts or in rise or dip workings, we will assume a particular case. Suppose before starting a fan the water gauge reading at *U* is .5'', and indicates a positive air column that will assist the action of the fan; and suppose further, when the fan is started and run at, say, 50 revolutions per minute, the water gauge at *S* reads 2''. The ventilating pressure is then $2 + .5 = 2.5''$. If now, the fan is speeded up to 100 revolutions per minute, the water gauge reading at *S* would increase to $(\frac{100}{50})^2 \times 2 = 8''$, supposing the efficiency of the fan to remain constant. This is in accordance with the accepted theory that the quantity of air in circulation varies as the speed of the fan, and the pressure varies as the square of the quantity or as the square of the speed. In practice, however, the quantity varies in a ratio somewhat less than the speed of the fan, and the pressure varies accordingly. Thus, it accords more nearly with the results of practice when we say the quantity varies as the fifth root of the fourth power of the speed ($\sqrt[4]{V^4}$), and the pressure as the square of this ratio. If this be correct, when we double the speed of the fan we will obtain $\sqrt[4]{2^4} = 1.74$ times the quantity, and $\sqrt[4]{2^4}^2 = 3.04$ times the pressure.

For the present purpose, however, assuming the efficiency of the fan to be constant, and the quantity to vary as the speed, and the pressure as the square of the speed, we have 2'' w. g. at 50 revolutions, and 8'' w. g. at 100 revolutions. The ventilating pressure in each case being $2 + .5 = 2.5''$, and $8 + .5 = 8.5''$.

The ventilating pressure is thus increased $\frac{8.5}{2.5} = 3.4$ times, instead of 4 times, as would be indicated by the water gauge at *S*, if this were the only gauge in use.

If the air column in the shaft is negative and acts to retard ventilation, the ventilating pressure increases from $2 - .5 = 1.5$ to $8 - .5 = 7.5$ or $\frac{7.5}{1.5} = 5$ times. In other words, when we have doubled the speed of the fan, in the case, we obtain only 3.4 times the ventilating pressure when the ventilation is assisted by the constant air columns, but when it is retarded by these columns we obtain 5 times the pressure. From these facts it will be observed that the water gauge reading at *S* must always be used to show the true variation of pressure due to the fan's action alone, while

the water gauge at *U*, for flat seams, and the corrected water gauge at *U* for inclined seams, must be employed to show the correct variation of the pressure producing ventilation.

Determining the Efficiency of a Ventilating Fan.

The testing of a fan to be used for ventilating purposes is a matter of prime importance. In the choice of a fan, one of the first questions that we ask is in regard to its efficiency, and we are often surprised when we are told that a certain fan presents an efficiency of 70, 80, or even 90 per cent. We accept this statement with a certain seasoning of salt, as we are familiar with numerous fans that are doing satisfactory work, and that have efficiencies varying from 50 to 60 per cent. Indeed, we have seen statements to the effect that the efficiency of certain types of ventilating fans cannot rise above 50 per cent. These facts together with observations made upon fans in actual practice, cause us to regard with considerable doubt the statement that a fan has an efficiency of between 80 and 90 per cent.

The real reason for these varying statements may be attributed largely to a conflict of terms. There are several meanings for the term efficiency. The term always refers to a ratio between theoretical and practical results. For example, an engine may show by calculation based upon its size, type, valves, etc., that it is capable of developing one hundred horsepower. In a test, the indicated horsepower of this engine as obtained from the engine card, may fall short of this amount, and may equal only, say 65 horsepower. We then say that the engine has an efficiency of 65 per cent., meaning that the effective horsepower, or the horsepower available for moving a given load, is 65 per cent. of the calculated or theoretical horsepower, the balance being absorbed in the engine.

The term efficiency as applied to a fan, is complicated by numerous misunderstandings. In some cases it is taken to mean the ratio between the actual and the theoretical pressure which the fan will develop; while in other cases, the term refers to the ratio between the actual and theoretical power. In conducting a test to ascertain the efficiency of a fan, the mistake is usually made of including the efficiency of the engine employed to drive the ventilator. A card is taken from the engine driving the fan, and the power estimated from this card. This method, of course, includes the power consumed in running the engine. The mistake would not be so bad in effect, if the efficiency of the engine varied as the efficiency of the fan; but this is not the case, inasmuch as the efficiency of an engine is usually greater as the speed is increased, while that of the fan decreases as the speed increases.

There are other causes which render the results of fan tests unreliable and extremely variable. These are the methods of measuring the velocity of the air-current or the quantity of air in circulation, and the ventilating pressure; the neglect to observe the temperature of the air at the point where the velocity and pressure are measured, and the barometric pressure. Whatever increases or decreases the density of the air affects the work of the fan and its efficiency as a ventilating motor. It is therefore important in making any true fan test that the velocity, pressure, and temperature of the air should be taken at a point in the airway or fan drift not too far removed from the fan, but at a sufficient distance to avoid the oscillations incident to its action. The size of the airway at the point where these observations are made, should be carefully measured and its area computed. While taking the observations, care should be used not to allow the body of the observer to decrease the area of the airway, as the velocity of the air-current will be much too high, if this is the case. Another precaution necessary in measuring the velocity of an air-current with the anemometer, is to move the anemometer to different positions in the airway so as to secure an average reading. It is well known that the velocity of the current is greatest at the center of an air-course and much less as we approach the perimeter, where the air is rubbing along the sides, top and bottom of the airway, and is retarded. A reading taken in the center will be too high, while a reading taken near the side will be too low. Another precaution to be observed occurs when there is a tendency of the air to flow along one side of the air-course. This is the case when the airway is curved or changes its direction; or the same effect may be produced by some obstruction in the airway, which too frequently escapes the notice of the observer. Quite frequently it occurs that the anemometer used is unreliable and does not indicate correctly the velocity of the air-current. The instrument should be tested, from time to time, by comparison with other instruments. Its accuracy may also be proven by the powder or flash test, but this should be carefully made.

Still another source of error by no means unimportant although very common, is the neglect to allow for natural air-columns existing in the shaft, or in rise or dip workings. Since this is a grave error it will be explained in a separate article upon

"False Water-Gauge Readings." The reading of the water gauge in all such cases should be corrected to give only the pressure due to the action of the fan. Too often, the total pressure producing ventilation is assumed to be the pressure due to the fan or ventilator, which may be the case in some instances, but in the majority of cases this total pressure does not correctly express the pressure due to the ventilator.

Manometrical Efficiency.—We have referred to the fact that the term efficiency as used at different times and by different persons, relates to different ratios, it sometimes being understood to mean the efficiency between the actual and theoretical pressures, while at other times it is taken to mean the ratio between the actual and theoretical powers. The term *manometrical efficiency* has always the former significance. The actual pressure is obtained from the reading of the water gauge, while the theoretical pressure is calculated from a formula based upon the assumption that the theoretical head due to the action of the centrifugal ventilator is one-half of the theoretical head due to the tangential velocity of the blade tips. The formula expressing the theoretical water gauge due to a ventilator is,

$$I = \frac{v^2}{g} \times \frac{12 \times 1.2}{1,000}$$

In which I = theoretical water gauge (inches); v = tangential velocity of blade tips (feet per second); g = force of gravity (32.16); $\frac{1.2}{1,000}$ = approximate ratio of density of air to density of water; 12 is a factor reducing the head of the air-column from feet to inches.

To obtain the manometrical efficiency we use the formula

$$K = \frac{i}{I} \times 100.$$

In which K = efficiency (per cent.); i = water gauge due to the action of the ventilator.

EXAMPLE.—The water gauge reading taken from the fan drift at the top of the shaft is 2 inches. The fan is a 10-foot fan, making 160 revolutions per minute. Determine the manometrical efficiency of the fan.

$$\text{SOLUTION— } d = \frac{3.1416 \times 10 \times 160}{60} = 83.78 \text{ ft. per sec.}$$

$$I = \frac{83.78^2}{32.16} \times \frac{1.2 \times 12}{1,000} = 3.14.$$

$$K = \frac{2}{3.14} \times 100 = 63.6 \text{ per cent.}$$

Mechanical Efficiency.—This term refers to the ratio between the actual and theoretical powers. By the actual power is here meant only that portion of the power producing ventilation that is due to the action of the ventilator, as the term actual pressure, used above, applies only to that portion of the pressure producing ventilation, which is likewise due to the ventilator. The mechanical efficiency would be consistently calculated from a formula giving the theoretical work performed by the ventilator. The difficulty is, however, to obtain an expression for this work that is applicable to all machines under all conditions. The fan formulas proposed by M. Murgue have not been found of sufficient utility to base the calculation of the work upon them. The chief objection to these formulas lies in the fact that they are given in terms that are not sufficiently tangible and are not readily comprehended. They do not show the influence of the breadth of the fan blade upon the yield, or the effect of atmospheric conditions; they do not discriminate between a small fan running at a high speed or a larger fan running at a lower speed, except in the matter of the equivalent orifice of the fan. This last factor especially, has been so little understood, in making many fan tests as to have led to much confusion and error.

In view of these facts, it has come to be common practice to base the mechanical efficiency of a fan, upon the indicated horsepower of the engine as obtained from the engine card, instead of upon a theoretical formula. This practice has given rise to other errors, to which we have previously referred; namely, the including of the efficiency of the engine in the efficiency of the ventilator. The question that interests all users of power is, What per cent. of the power applied is made useful, in performing any allotted work? Practice does not concern itself with the question as to whether any given formula or expression is correct; but, if 100 horsepower is applied to the driving belt or to the crank shaft of a fan, what percentage of this power becomes effective upon the air, in the use of different types of fans? This is the practical question. Scientific investigation will continue to analyze formulas, in the interest of correct machine designing, but the practical test will always be that referred to above, to ascertain the ratio between the effective power and the power applied to the fan shaft.

We would suggest when the engine card is used as a basis for

finding the efficiency of a fan, that the following method be employed: (1) Run the engine at several fixed speeds with the belt thrown off, or with no load upon the engine, and take engine cards at each given speed. (2) Run the engine at the same fixed speeds as before, under the load induced by the revolution of the fan, and take engine cards for each given speed, under this load. Calculate the total work in each respective case, deducting the work of running the engine under no load from the work performed at the same speed, when the fan is in operation. The difference will be the power applied to the fan shaft for each respective speed. This work would not naturally agree with the work expressed by a formula, inasmuch as the work absorbed by the mechanical revolution of the fan has not been deducted; but practice would usually prefer that this should not be taken out. In other words, from a practical standpoint the efficiency of the ventilator should preferably include the power necessary to revolve the ventilator. From a scientific standpoint, as far as the formula goes, it would be desirable to eliminate the work performed in the mechanical revolution of the ventilator. This can readily be accomplished by taking the first set of engine cards at the same fixed speeds when the fan is in operation, but the resistance of the mine has been cut off by suitably arranging the doors in the fan drift and casing. By this means, the difference of work as calculated from the two sets of engine cards, at each respective speed, will represent the actual work performed upon the air, at each speed, and should correspond to the work indicated by the expression Qp . There may not, however, be complete correspondence, inasmuch as the methods at hand for measuring the velocity and pressures of air-currents are to a considerable extent crude.

Methods of Shaft Timbering.

The amount of timbering employed in lining a shaft depends wholly upon the character of the strata passed through. Where the strata are self-supporting, that is to say, do not tend to chip or break off and fall into the shaft, the shaft lining is usually omitted; cross-buntings only being used to furnish the necessary support for the cage guides and for the lines of pipe, signal wires, etc. usually carried down the shaft.

The character of the strata will change very materially as sinking progresses. After passing through the surface soil, or drift, as it is called, there is usually encountered a hard-pan of clay or other rock material; or there may be a sub-stratum of gravel or quicksand at this point, with a hard pan below it. The strata of the coal measures are especially variable, and alternate from soft to hard and *vice versa*, quite often in the course of sinking. Test bore holes at the location of the shaft have usually made known this character before the operation of sinking has been commenced.

In the sinking of deep shafts the manner of lining the shaft is often changed to conform to the character of the strata at any point of the sinking. Shaft lining is, of course, employed at all points where the strata are not self-supporting, and is carried down until a hard stratum is reached of sufficient thickness to warrant the abandoning of the shaft lining. Cross buntings are then used while passing through the harder strata and lining again introduced if softer strata are encountered below. When this is done arrangements must be made for the handling of the water coming from the strata above the hard pan, either by the laying of a water tight curb, or building a coffer dam as described later, and conducting the flow of water above this point down the shaft in pipes. In the sinking of shallow shafts it is not customary to abandon the shaft lining when a hard stratum of a few feet in thickness is reached. In general, the lining of shallow shafts is made continuous from top to bottom, where lining at all is required.

Water and Quicksands.—In shaft sinking in a synclinal basin, the existence of an impervious stratum or hard-pan is usually heralded by a considerably increased flow of water. According to the character of the surrounding country, the flow of water encountered may have a considerable head. As long as the character of the strata is such as to render them quite firm and self-supporting, the water these strata contain will cause little trouble until nearing a hard-pan or stratum that is impervious to the flow of water. At this point the water accumulates, and when dammed back may exert considerable pressure. When there is a sub-stratum of sand immediately overlying the hard pan, the worst conditions in sinking are realized; especially, if the thickness of the sand is considerable. Such a stratum is known as a *quicksand*. A quicksand of some thickness, at a considerable depth below the surface, presents some of the most troublesome features encountered in shaft sinking. The sand flows with the water as a fine hard-grained silt that cuts the linings and valves of the pumps used to drain the water from the shaft. This flow of sand in the water that is being pumped gradually undermines

the overlying strata, often causing a settlement that may injure the shaft lining. For this reason it is important in passing through a stratum of quicksand, to choke its flow behind the shaft lining as much as possible. This has been accomplished at times by means of alternating thicknesses of shaft curbing, so arranged as to present a corrugated or uneven surface at the back of the lining, or against the sand. This is shown in Fig. 1, where alternating layers of 2"×8" and 2"×10" plank are used. The result of this is that the flow of water and sand running down behind the curbing tends to choke itself. This arrangement of the curbing has always produced a marked effect upon the amount of flow, both of sand and of water.

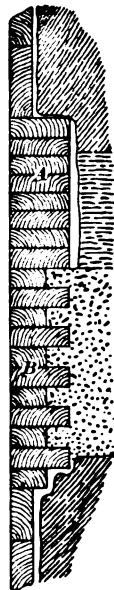


FIG. 1. TIMBERING TO KEEP BACK WATER AND SAND.

In passing through a free quicksand it is often necessary to keep the curbing well down to the bottom of the excavation, as shown in Fig. 2. The work must be accomplished rapidly. When the thickness of the sand is not great, or the stratum lies

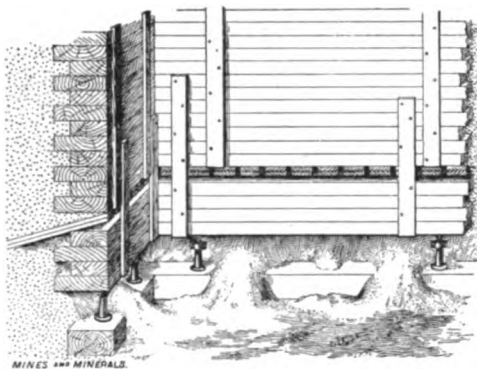


FIG. 2. BOTTOM SUPPORTS.

at a shallow depth below the surface, it may be passed through safely in the manner shown in Fig. 2. When, however, a quicksand lying at a greater depth and of considerable thickness is encountered, other apparatus (see Fig. 4) will be required. An iron shoe or muf, fitting the outside of the shaft curbing, as shown in Fig. 4, is often employed at the bottom of the shaft, in such cases. The shoe or muf is carried down in advance of the curbing by excavating the sand from beneath it. When this is done the jacks shown in Fig. 2, are made to rest upon cross timbers supported by the shoe. These jacks are used to force the shoe downward, while they act also to support the curbing above.

At times when the flow of sand is quite free, short sheathing piles or spiles are used as shown in Fig. 2, to temporarily choke the flow of the sand. These spiles are driven through the curbing between the sets, as shown. They are often used in this manner when the curbing has parted; but great care must be taken to give

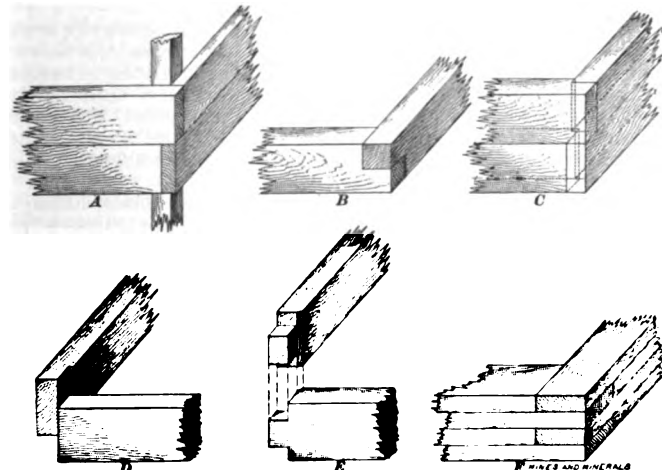


FIG. 3. JOINTS.

support to the curbing below, as the use of the spiles throws additional weight upon it. Indeed, their use has often proved an evil in the end, although they always provide a temporary relief.

It often happens in sinking through quicksand or when the shaft has nearly reached a stratum of quicksand, that the sand boils. An outburst frequently occurs in the bottom of the shaft,

under such conditions, that overwhelms the sinkers before they are able to escape. At such times, the sand and water sometimes rise to a great height in the shaft, and remain for a while, when they will again subside. This boiling of the bottom of a shaft forms one of the most dangerous features in connection with sinking.

Swinging of the Shaft Curbing.—One of the results of sinking through quicksand of any considerable depth is the tendency of the shaft curbing to swing out of line, or to twist, as the case may be. When this takes place it usually results in the enforced abandonment of the shaft, except where the shaft is circular, or the excavation is larger than is required in the completed shaft. To avoid such an occurrence the shaft curbing, under such conditions, is often secured by dropping sets of rods from the surface, and tying up the curbing in sections to prevent its sinking. This method is illustrated in Fig. 4. Cross-buntings are introduced at intervals of 8 or 10 feet, and the vertical rods passed through these cross-buntings, which in turn carry the curbing. To prevent, as far as possible, the swinging of the shaft, an additional system of diagonal bracing is sometimes carried down the shaft.

Framing of Shaft Timbers.—In the framing of shaft timbers several forms of joints are used. Regard must always be had to the expense of framing as well as to the efficiency of the joint for resisting pressure, and the ease with which the timbers may be inserted. Several of these forms of joint used in lining shafts are shown in Fig. 3. The simplest form of joint is that shown at A, Fig. 3. In this form, there is no framing required; the alternating sets are arranged to break joints, as shown in the figure, and a triangular corner piece is spiked firmly from top to bottom of the shaft. This forms a very efficient and cheap method of curbing shallow shafts. The form of curbing shown at B, is adapted to heavier pressures and deeper shafts. The form of joint shown at C, is a very cheap and efficient joint, used in passing through particularly loose strata where difficulty is often found in placing the sets. Each alternate set is arranged to break joint. At D is shown the same form of framing as is employed at C, but the timbers are not arranged in complete sets, the shorter lengths being always sprung into and supporting the longer timbers. This method is not often employed, as it does not furnish sufficient protection against side pressure upon the short lengths. The form of joint shown at E, is more expensive, although a very efficient joint. At F is shown the manner of alternating layers of thin plank while passing through quicksand or running strata. The planks are spiked upward from below, as they are inserted.

Thickness of Shaft Curbing.—Where the strata are self-supporting, 4-inch planks set upon edge, form a very good shaft lining to the depth of 50 or 75 yards. A lining of 3-inch plank has often been used with good results to a depth of 40 or 50 yards, in firm strata. Where a considerable flow of water is encountered and a coffer dam is built to dam back the water, the thickness of the curbing must be very much increased. In such cases, the following formula may be employed to determine the thickness of white pine curbing which will resist a given head of water.

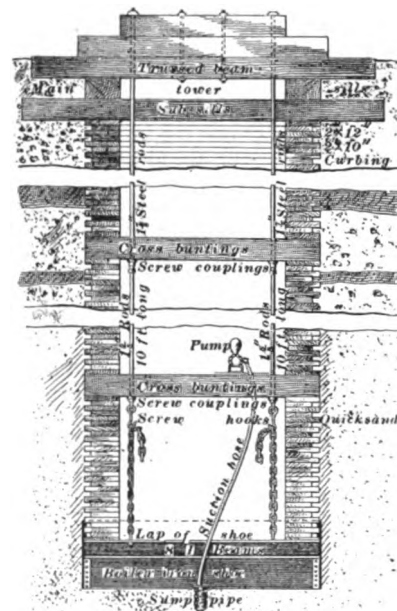


FIG. 4. BOTTOM SHOE.

$$t = .016 s \sqrt{d},$$

in which t = thickness of curbing (inches); s = clear, unsupported span of curb timber (inches); d = depth below the surface (feet). This formula, however, makes known the worst case that could occur, when the water obtains a head at the surface of the shaft, and is not to be employed ordinarily.

Wedging Curb.—What is termed a *wedging curb* applies more particularly to a circular shaft. It is a curb made in segments, to be laid upon an off-set or shelf cut in a hard stratum, and afterward wedged firmly in place to form a suitable foundation for the curbing above. A water-tight joint is made at this point, by

packing the space behind the wedging curb very tightly with moss. Wedging curbs, strictly so-called, are not employed in sinking a rectangular shaft, but in their place is often used a curb of heavy timbers laid in cement upon a shelf of hard rock. This curb furnishes a foundation for the construction of a coffer dam, which is simply a tight shaft lining of heavy timbers, laid with a tar-felt joint to exclude the water. Sometimes the timbers forming the coffer dam are mortised together to provide a water-tight joint. It is important to leave weep holes, or to provide for the drainage behind the shaft curbing at this point, by suitable pipes that will conduct the water to the bottom of the shaft. In some cases, there is excavated in the hard pan behind the shaft curbing, a sump of sufficient size to hold the water that accumulates, and to locate at this point a pump for raising the water to the surface. By this means, there is a considerable saving of power by not allowing the water to drain to the bottom of the shaft. In this arrangement, it is usually necessary to excavate a small manway entirely surrounding the shaft. The excavation should be well timbered.

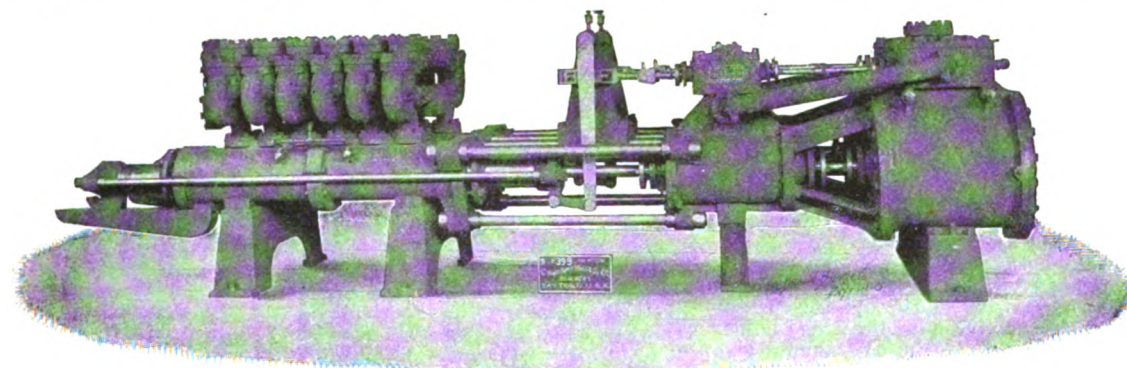
[Very complete descriptions of shaft timbering in different sections of the country will also be found in MINES AND MINERALS for Sept. 1898, page 49, and June 1900, page 481, and page 103 of the present number.]

A New Design for a Compound Duplex Pressure Pump.

The illustration shows a compound duplex pressure pump, designed to develop a maximum pressure of 700 lbs. per sq. in. The liquid end is of the end-packed trombone style; the cylinders are made of special metal, and mounted thereupon are separate chambers for the location of the valves; these chambers are also constructed of special metal and are designed with a view of facilitating quick access for the inspection of the valves.

The valves are of the hydraulic pattern, made of steel, and guided from below. An extension piece is provided for supporting the water plunger, and an approved adjustment device provided therefor.

The water end is mounted on heavy supporting columns. An engine of the transposed cylinder type is furnished, giving



SMITH-VAILE COMPOUND DUPLEX PRESSURE PUMP. POT VALVE STYLE.

free access to all steam pistons without dismantling the pump. The outside valve adjustment is a feature of this design.

One of these pumps was recently installed and is now in use by the El Paso & Northeastern Railway Co. at the Summer resort of Cloudercroft N. M., a beautiful resort in the Sacramento Mountains, situated over 8,700 feet above the sea level, and reached from El Paso, Texas, via the E. P. & N. Railway "Cloud Climbing Route." The pump is used to furnish the entire water supply for the resort and also for railway company's tank use. It pumps the water from a distance of three miles and to an altitude of 600 feet. During the past summer the pump has been supplying the town of Cloudercroft, having a population of from 1,200 to 1,500 people, with its entire water supply, and the railway company with its water tank supply. However, the pump has not been worked to anything near its capacity and the railway company now contemplates using the superfluous water for the purpose of making a lake.

Further particulars regarding this style of pump may be obtained by addressing the manufacturers, the Stilwell-Bierce & Smith-Vaile Co., 287 Lehman Street, Dayton, Ohio, U. S. A.

According to Prof. Borchers, the eminent electrometallurgist, the world-manufacture of calcium carbide is utilizing a power equal to 180,000 horsepower; that of the alkalies and the combinations of chlorine, 56,000 horsepower; of aluminum, 27,000 horsepower; of copper, 11,000 horsepower; of carborundum, 2,600 horsepower; of gold, 455 horsepower.

Some Placer Mining Notes and Wrinkles.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

In endeavoring to locate old river channels remember that water is a lazy fellow and will try to seek for its course the easiest way and the place of least resistance. It is therefore apt to work the easiest and softest ground first till it is all used up, and then it reaches the hard steep rock bank and stays there. Hence old river channels in a broad placer river valley are not infrequently found hugging the hardest and steepest rock bank.

For natural rock riffles, naturally catching and arresting the gold, much depends upon the way the bed rock strata, such as slates or shales, dip. If they dip down stream, with edges tilted up stream, they catch the gold, but if the strata dip up stream, the water with the gold flows over them, and the sand and gold are apt to glide over the edges of the strata and not deposit until some other obstruction is met.

In the case of potholes, which to the novice would seem most attractive places for gold deposit, it is a curious fact that these are generally disappointing; the waterfall and churning water which hollowed it out seem to have washed the smooth pothole quite clean of whatever gold may have temporarily been deposited in it. It has been observed that if the bank above the pothole descends steeply, the pothole is liable to be empty of gold, and the gold it may once have held may be found farther down on the rim. If there is a sliding surface from the pothole down stream the gold is liable to be caught not far below the pothole especially in bed rock dipping down stream.

In hydraulic mining, in two pipes or nozzles, one wide the other narrow, the big pipe will carry more cannon-ball like force or volume, and do more general damage along a placer bank; the narrow one will shoot more like a rifle and its damage be confined to a small area. For far shooting all depends on compressing the water power within narrow limits. A two inch nozzle will shoot farthest, but a four inch nozzle will do most damage.

A pipe under pressure of only 35 ft. head might throw 60 feet, whilst the same with 300 feet head, would throw water a far greater distance.

A flume may get choked by too great and sudden a rush of water and material.

Blasting large boulders in a placer is often found cheaper than moving them by cranes, or other means. Blasting of this kind is commonly done by laying a stick of dynamite on a boulder of average size, covering it with loam and then firing it.

In beginning to work, or develop a new placer ground, work up stream from below.

Grading for the flumes may be up to eight inches in twelve feet. Supposing an obstacle occurs in the flume, temporarily choking it, instead of tackling it at the exact point, where the obstruction is, go below it and clear the down stream end of the obstruction. An obstruction is liable to occur at change of grade in a flume from 6 inches to 4 inches.

A giant nozzle often cuts down rather than undermines a bank, and drives material before it to the flume; this is in shallow banks; in deep banks under-mining is necessary, of course.

It is not well to put a giant too near to the mouth of a flume, or the volume of the water and debris flying before it would be liable to choke the flume. If the giant throws water about 60 ft. it should be located at least 120 ft. from the mouth of the receiving flume. The flume cutting ditch may cut back a canyon to the bank 20 to 50 ft. long, and 20 to 30 ft. deep in a day. A bank may be undermined by the nozzles in a sidelong manner, as well as by directing the water against it point blank. Men digging up bed rock throw it as well as the gravel into the flume to go over the riffles. The flume is built onwards as the banks are cut farther back. A powerful head or powerful water pressure is the great thing needed in hydraulic mining. As there is a great deal of noise around a hydraulic placer signals are made by a whistle, or by movements of the arms. The main difficulties to be overcome in a flat placer, like in an open meadow with a not too rapid stream going through it, is to dispose of the debris, or detritus. Placers of this kind are apt to get choked with their own debris, unless means are available for removing it.

For original contributions upon mining or metallurgical topics descriptive of new and handy devices and appliances we will pay at the rate of five dollars (\$5) per column, payment to be in technical or scientific books to be chosen by the contributor.

By S. J. Routledge, Ensley, Ala.

The slope was 2,700 feet long and the profile is shown in the figure.

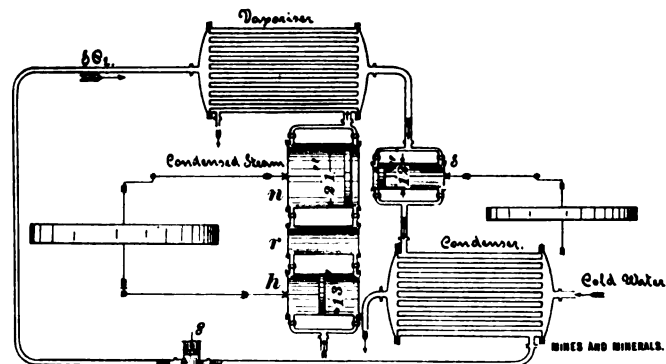
Diagram of a road profile showing a 6% dip, a 4% dip, a 3% dip, and a 5% dip. The road is 1500 ft long and has a 1200 ft section with a 5% dip. The road is labeled "Engine" and "Pin pulled here".

It took only 3 men and 1 mule to operate the tail rope, one man on the rear of the front trip and one man on the front of the rear trip, one mule to pull the empties down, and one driver. Before we put our rope in operation we were only getting 200 tons with 6 mules from this part of the mine but after we got the rope in and the men acquainted with their work we averaged 790 tons. We have been using the tail rope for seven years and are still running it to get coal from this part of the mine.

In March, 1900, 282 stones were found 250 miles up the Mazaruni River. They were sent to London, where they were examined and the lot valued at \$12 per carat. Recently 400 small stones were brought down from the same locality. They were washed out by nine men in eighteen days by very crude methods. The stones are octohedron, varying in weight from a decimal of a grain to a carat and a half in the crude state. London dealers

By Frank H. Mason, United States Consul General at Berlin.

It is plain that, with all progress which has hitherto been made in steam-engine practice through higher pressures, superheated steam, economical cut-offs, or successive cylinders, there is always an important and inevitable loss of heat energy when the steam, having done its work, is discharged into the open air or changed back to water by contact with cold water in a condenser. When the exhaust is into the open air, the steam has



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without corroding them. Their demonstrations, although not practically conclusive, were so promising that Professor Josse, as a technical authority on this subject, took up the problem, and, after several months of highly satisfactory laboratory experiment, caused to be constructed and connected with an ordinary working steam engine of the compound type an additional condenser and auxiliary engine, the power of which could be exactly measured. The whole working apparatus is shown in the figure herewith submitted, and the technical details will be explained by the drawing, and may be thus described:

Referring to the diagram, in which dimensions are given in millimeters, h and n represent the high- and low-pressure cylinders of an ordinary compound steam engine, with a stroke of 19.69 inches and a speed of 41.5 revolutions per minute. From the low-pressure cylinder n the exhaust steam passes into the surface condenser, called in the diagram the "vaporizer." In this vaporizer, or condenser, the cooling medium used, instead of water, is liquid sulphurous acid (H_2SO_3), which has a boiling point so low that it is immediately decomposed by the heat of the exhaust steam, whereby the sulphur dioxide gas (SO_2) is liberated, which passes over into the cylinder of the auxiliary engine S , where its work is done as in an ordinary steam engine. The auxiliary cylinder has a diameter of 12 inches; and a stroke of 19.69 inches, with a speed of 77 revolutions per minute.

After passing through this cylinder, the sulphurous vapor enters the surface condenser, around the tubes of which cold water flows as in an ordinary steam plant. Here the sulphurous vapor is condensed to liquid and is forced by the pump back into the vaporizer, where it begins its cycle again, the same SO_2 being used over and over again indefinitely. There are, therefore, in fact, two condensers, the first serving, as it were, as a boiler or steam generator for the auxiliary engine; and this boiler, instead of being fired by coal, obtains all its heat from the exhaust steam from the engine, and, instead of converting water into steam, evaporates a liquid which is much more volatile—i. e., has a far lower boiling point.

In the long series of recorded tests with the plant shown in the figure, the following results were attained:

The steam engine is of the compound type, of good modern construction, and, being given a steady load, developed 34 indicated horsepower, with a consumption of 18.96 pounds of steam per indicated horsepower hour. The auxiliary machine working with the sulphurous vapor indicated 19 horsepower—that is, an increase of 56 per cent. and yielding, instead of 1 horsepower, 1.56 horsepower for the same steam consumption and reducing the steam consumption from 18.96 to 12.13 pounds per indicated horsepower.

The experiments showed on the average that for every 33.169 pounds of steam passing through the main engine 1 horsepower could be gained in the auxiliary machine. Applied, therefore, to an ordinary single-cylinder steam engine, exhausting into the air at high temperature, the percentage of power saved by this new device would be very much higher than the economy reached in these experiments, which, as has been shown, were made with a highly improved compound engine. From the average of these experiments, it may be broadly stated that, given a fairly economical compound engine, using 16.5 pounds of steam per indicated horsepower hour, half an indicated horsepower could be produced in the auxiliary machine for every indicated horsepower developed in the main engine. Assuming an average vacuum of 23.62 inches, corresponding to a temperature of 140° F., the saving of heat must be accomplished by using a liquid which can be vaporized to a high pressure at or below that temperature. Assuming, further, the upper and lower limits of temperature within which the operation is confined to be 140° and 67° F., the pressure of the sulphurous vapor would range from 10.05 down to 2.35 atmospheres above open-air pressure. A working pressure as high as ordinary steam-boiler pressure is therefore readily obtained at a comparatively moderate temperature. Moreover, the volume of sulphurous-acid vapor necessary to contain the number of heat units corresponding to the work to be performed is much smaller than the volume of steam which would be required for the same purpose. As the saving to be effected by the auxiliary engine depends directly upon the difference between the highest and lowest temperatures involved, the greatest gain will therefore be made either when the water in the surface condenser is as cold as possible or when the heat of the exhaust steam from the engine is at a maximum, as is the case with a single-cylinder steam engine without condenser, which may be anywhere up to 212° F.

The expense of this improvement is practically all in the construction cost of the vaporizer, condenser, and auxiliary engine itself, and its economy may be realized from the fact that the exhaust steam from a 2,000-horsepower central-station engine should furnish power to drive an additional 1,000-horsepower engine, which can be connected as an extra cylinder to the steam

engine or run independently, and thus increase by 50 per cent. the power developed without adding a pound to the quantity of fuel consumed. When, in view of the present coal famine throughout Europe, it is remembered that the steam-engine energy of Germany alone, afloat and ashore, is not less than 3,717,264 horsepower, the commercial importance of such an improvement will be readily apparent.

A New Water Purifying System.

It is generally known that even a small accumulation of scale will greatly increase the fuel and repair bills, reduce the capacity and efficiency of the plant and cause the burning out of boiler tubes. In some districts this scale proves so troublesome that it is difficult to keep a plant in operation without frequent interruptions for the purpose of cleaning and repairing the boilers and replacing the tubes. Most up-to-date superintendents have long been figuring on the installation of some system which would remove all scale-forming ingredients before the water reaches the boiler. The Tweeddale system as described by the Chicago Boiler Cleaner Co. is based upon the principle that all foreign substances whether held in solution or suspension can be released by electrical and chemical action, and precipitated to the bottom of the tank, whence they are easily drawn off.

The apparatus itself consists of a pair of tanks which hold a water supply sufficient for six hours' run. In the bottom of each tank is located an aerater and oxidizer combined. This device contains a system of metallic plates filled in with coke, which sets up a chemical or galvanic action in the water.

A strong jet of air is forced through the oxidizer and aerater pipes producing an agitation and aeration which combined with the electrical action and chemical reagents cause first a thorough mixture of all the contents of the tank, and then a releasing of the impurities held by the water. At the proper juncture a small quantity of a standardized reagent is injected, and when the disturbance ceases the water unites with the base of the reagent forming a coagulated mixture which seizes upon the released impurities and, acting as a filter, carries them down to the bottom of the tank by ordinary precipitation at the rate of about 12 ft. per hour.

No mechanical filter is required. Any filtering apparatus must not only be expensive to install and refill, but almost impossible to thoroughly clean. The only filter employed is that which forms in the water itself, and carries the released impurities to the bottom of the tank by ordinary sedimentation.

At the end of this process water which was cloudy and muddy before is said to become clear as crystal, so that a pin at the bottom of a ten foot tank is visible to the naked eye. Not only is it claimed that the water is clarified but it is also purified and softened so that it becomes palatable to the taste and delightful to the touch. The purified water is drawn from the surface by floating pipe connections, while precipitated impurities are carried away by waste pipes located at the bottom of the tank. While one tank is being treated as described above the water supply is taken from the companion tank. The whole process is amazingly simple, effective and economical, and apparatus and reagents employed are quickly understood and easily handled by the ordinary engineer. Water treated by this process will under no circumstances produce scale formation in boilers. Not only this, but the elimination of scale-forming ingredients will soften and eventually remove whatever scale has already formed.

This system eliminates what is perhaps the most disagreeable and expensive feature of steam production, and easily pays for itself in the increased efficiency and economy of the plant.

The manufacturers are prepared to install a complete purifying plant for any responsible firm with the understanding that if it does not meet their requirements and do exactly as claimed it will be removed free of charge. For further particulars, plans, specifications, blue prints, etc., address the Chicago Boiler Cleaner Company, 321 Dearborn St., Chicago, Ill.

In a letter to *The Times*, Sir W. B. Richmond, president of the Smoke Abatement Society, states that there are about 18 million tons of coal consumed annually in London, costing some 16 millions sterling, of which probably 3 million tons are consumed by gas and other manufactories. About two-thirds of the heat produced by the combustion of coal is lost in the ordinary grates by passing up the chimneys, and the loss thus incurred is about 8 millions sterling a year. It has been proved beyond dispute that factory furnaces can be quite easily rendered smokeless, and at a saving to their owners of from 10 to 20 per cent. of the fuel consumed. With the use of the automatic feeder far cheaper coal than anthracite can be adopted. The technical committee of the Coal Smoke Abatement Society has examined and approved grates which, while they maintain the open fire, consume all the carbon, and hence no appreciable quantity of smoke ascends the chimney.

NEW INVENTIONS.

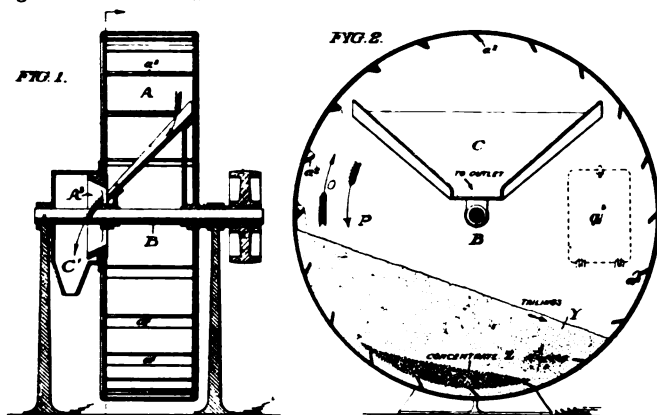
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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MEANS FOR CONCENTRATING ORES ANHYDROUSLY.

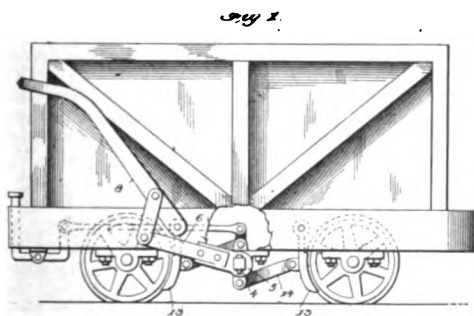
No. 655,496. SAMUEL MARION, PHILADELPHIA, PA. *Patented Aug. 7, 1900.* This invention provides for concentrating ore or sand containing valuable metal without the use of water. A drum *A* is rotated



upon the shaft *B*, and has an inlet closed by the door *a'*. Within the drum, a fixed discharge-chute *C* is so arranged that material dropped on it gravitates through the spoked outlet *A* to the discharge-hopper *C'*. The inner periphery of the drum *A* has wings *a*, which, in accordance with the direction of rotation of the drum, serve merely to agitate the material contained therein, or to pocket certain portions and deliver the same to the chute *C*. The operation of the apparatus is as follows: The drum is partially filled and is then rotated in the direction indicated by the arrow *P*, the wings *a* stirring the material so that the heavier particles gravitate to the bottom. The drum is next rotated in the opposite direction, as indicated by the arrow *O* with the result that the wings *a*, encountering the tailings *Y* pocket and carry them through the mass, beneath the valuable concentrate *Z*, and deliver the worthless material upon the chute *C*.

MINE-CAR BRAKE.

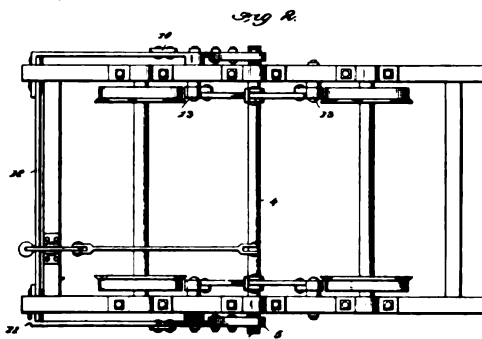
No. 653,722. HOPKINS J. WILLIAMS AND RACHEL MORGAN, NANTICOK, PA. *Patented July 17, 1900.* Journaled to the sills and intermediate to the wheels is a rock-shaft *4*, each end of which projects a slight distance beyond its bearings, and is preferably formed angular and provided with a removable casting *5*. Arms *6* are bolted in sockets in the casting and extend a short distance therefrom. A bail-shaped lever *8* is pivotally secured to the sides of the sills. A short link *10* is



pivotally secured to each side of the lever a short distance from its pivotal point and also to the outer end of the arm *6* upon that side of the car. The lever can be formed in any suitable manner, although it is preferred to bend each of the side pieces inwardly to form a lip *11*, to which is bolted a cross-piece *12*, which is grasped by the attendant and forced downwardly when it is desired to apply the brake.

The brake-shoes *13* are pivotally secured at their upper ends to the inner side of the sills. Each of the shoes is connected with the rock-shaft *4* by means of a link *14*, which is pivotally secured to the shoe at one end by means of a projection and secured at its opposite end to a

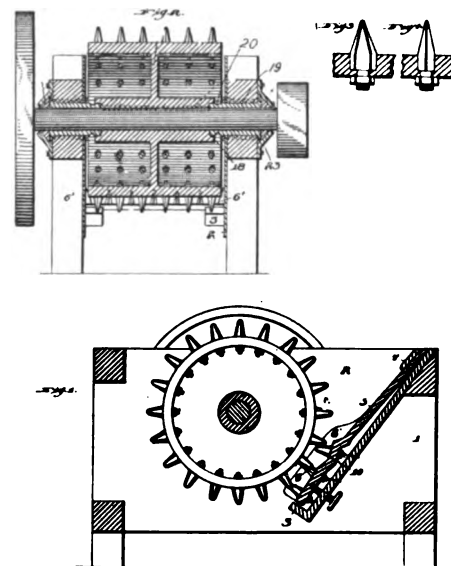
short arm, which projects from the shaft *4*. The arms at each end of the rock-shaft project in diametrically-opposite directions, so that the links from the shoes upon the opposite sides of the lever can be secured to said arms in such manner that the oscillation or rocking of the shaft will simultaneously move the brake-shoes toward or from the wheels. By constructing the parts in this manner the arms and links virtually



form the two members of a toggle-joint by means of which the pressure or force exerted by the compound-lever movements above described will be correspondingly increased, thus making the improved brake very effective in controlling the movement of the car, which is a very material consideration when the weight of the contents of the car is taken into consideration, which is frequently a ton or more, which must be wholly controlled by pressure applied to wheels of exceedingly small diameter. The same apparatus may be easily worked by a foot brake arranged as shown.

COKE-BREAKER.

No. 655,162. PHILLIP F. POORBAUGH, OF ALLEGHENY, PA., ASSIGNOR TO THE PITTSBURGH COAL MINE SUPPLY COMPANY, OF PENNSYLVANIA. *Patented July 31, 1900.* A rectangular frame is provided at one end with a triangular casing *2*, with a shoulder *3* at the bottom. The upper end

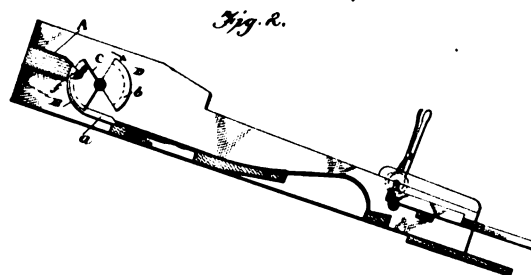
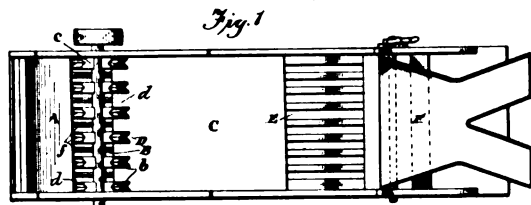


of the breaking-plate *5*, is secured by a cleat *4* while the lower end is normally supported by the shoulder *3*. This plate contains teeth bolted in place as shown. The body portion of these teeth is hexagonal and the teeth taper to a point at one end. The plate *5* at a point near its lower end has a bent portion *10*, the upper face of which is at an angle to the upper face of the remaining upper face of the lower part of the plate, as by such construction the upper row of teeth in the plate *5* is upon substantially the same relative plane as the teeth in the drum at the time each row of the latter teeth is about to pass between the upper row of teeth in the plate *5*. *6'* is a flange arranged at each side of the teeth *6* forming a fixed cutting-tooth at the sides of the plate. Each end of the hub of the revolving cylinder is provided with an annular offset, forming a shoulder *13*, which surrounds one end of the fixed bearing *19*. Near the inner end of *19* is a groove *20* to catch the dirt or dust and prevent the same entering between the joint of the shaft-bearing and hub. *23* is a dust-preventing flanged collar. The drum is suitably arranged to receive teeth which are of the same construction and secured in the same manner as the teeth for the breaking-plate. The drum-teeth are so arranged that when the drum is operated they will pass between the teeth of the plate and when in such position will be on the same plane as the teeth *6*.

COAL-SEPARATOR.

No. 655,580. JOHN R. RICHARDSON, OF SCRANTON, PA. *Patented August 7, 1900.* The coal enters the upper end of the chute and passes down the incline *A* to a more abrupt incline or dip *B*, made by a series of bars *a*, in the form of a grating that connects the inclines *A* and *C*. The spaces between the grate-bars are sufficient to permit of the passage of slate and culm and refuse of this nature. The coal and refuse coming down the incline are agitated by a rotary agitator *D*. This is composed of a shaft journaled in the side walls of the chute and a series of disks *b*, mutilated at opposite points by having quarter-sections cut out, leaving spaces. The disks are separated by spaces *d*, providing for the discharge of the culm and slate. These spaces are preferably wider than the spaces

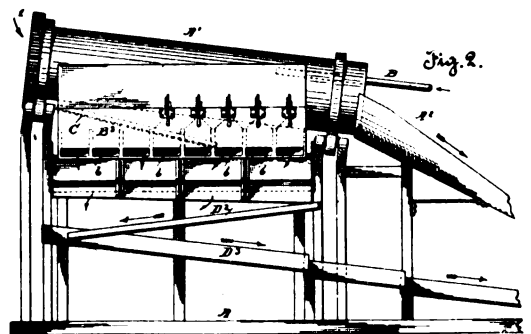
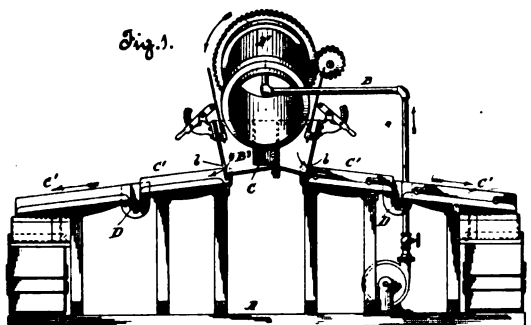
between the grate-bars, and in order to prevent clogging the disks *b* are made with grooved peripheries, adapted to closely fit the corresponding edges of the grate-bars, as shown at *f*. As the edges of the disks *b* project above the level of the upper incline *A*, the coal and refuse bank against it; but as the agitator is rotated the cut-out portions form pockets



into which the coal and refuse drop, the slate and culm passing through the spaces between the disks and the grate-bars. In the rotation of the agitator the contents of the pocket remaining is carried over and discharged upon the incline *C*. At the bottom of this incline there is a second grating *E*, its bars being given the form of a swell, and the end of the incline extends to an opening through which passes more of the refuse. As the mass slides up over the bent grate-bars *E* some of the refuse which may have passed the agitator and first grating passes through and the clean coal bounds upwardly by reason of the shape of the grating *E* and is caught by an overchute located above the main chute and directly in line with the swell or curve of the grating *E*.

GOLD-SAVING APPARATUS.

No. 652,900. R. H. POSTLETHWAITE, SAN FRANCISCO, CAL. *Patented July 3, 1900.* This invention relates to a special form of apparatus for recovering the gold from ore, tailings or placer material and is intended

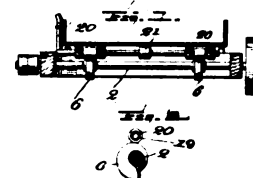


for use principally in connection with the dredge. The general arrangement can be understood by referring to the accompanying drawings in which *A'* represents an inclined trommel driven by any suitable mechanism, such as gearing. The material is introduced at the end only and subjected to the screening action of the trommel and to streams of wash water through the pipe *B*. The fine material escapes through the screen and drops into the distributing trough *B'* or the inclined screen *C*, the latter being intended for more evenly distributing the material in the trough *B'*. It will be noticed that the trough *B'*

inclines toward each side, but that the highest point is not placed in the middle. The object of this is that as the trommel travels in the direction indicated by the arrows the major portion of the material passing through the trommel will be thrown to the right and hence a smaller distributing box can be employed on that side and still equalize the amount fed to each trough. Any coarse material is distributed through the chute *A'*. On each side of the distributing box *B'* are placed tables *C'* which are covered with blanket or other fibrous material, held in place by means of a layer of expanded metal, which is firmly clamped on top of the fibrous material. A pocket *D* is arranged across the tables to act as a riffle and has a mercury well for collecting values. The flow of the material through the different tables is controlled by valves which regulate the openings *b*. The discharge from the ends of the table *C'* is received by the inclined trough *D'* and carried to the head of the machine where it is allowed to flow into the discharge or tailing trough *D''*. This trough is also provided with riffles in order to save any material which has escaped the tables above. The whole plant is intended to be erected upon the floor of a dredge, as *A*.

MINERAL-SCREEN.

No. 655,160. PHILLIP F. POORBAUGH, OF ALLEGHENY, PA., ASSIGNOR TO THE PITTSBURGH COAL MINE SUPPLY COMPANY, OF PENNSYLVANIA. *Patented July 31, 1900.* The rectangular frame is arranged at an inclination, and power is applied to revolve the shaft *2*, carrying cams *6*, *6'* thus elevating the screen *10* ins. by the contact of the cams *6* with the anti-friction-rollers *20*. This elevating of the screen-shoe discontinues when the smallest portion of the cam is reached, and the screen then falls upon the bumper *21*. This movement of the screen-shoe will cause the material to travel rapidly, as well as screening the same. During the fall of the end of the screen-shoe the oil contained in the hollow shaft *19* will be forced up through openings and lubricate the anti-friction-rollers. The inclination of the screen can be increased or diminished by the adjustment of nuts and if desired the fall or the lowering of the screen-shoe can be done more rapidly, by increasing the tension of a spring placed alongside of the frame of the screen by means of the nut *17*.



PATENTS ISSUED DURING AUGUST AND NOT ILLUSTRATED.

- | | |
|--------------|---|
| No. 655,784. | Excavator, G. W. King, Marion, O. |
| No. 656,555. | Drill-grab, G. I. Lewis, Lawler, Iowa. |
| No. 655,311. | Ore-crusher, T. Smith, Hopewell, N. M. |
| No. 655,793. | Quartz-mill, A. T. McMurtry, Medford, Ore. |
| No. 656,414. | Mining-machine, J. L. Mitchell, Galesburg, Ill. |
| No. 656,224. | Dredging bucket, C. H. Smith, Jersey City, N. J. |
| No. 655,955. | Excavating-machine, L. V. Brophy, Chicago, Ill. |
| No. 655,470. | Concentrator, W. H. Washburn, Oroville, Wash. |
| No. 655,218. | Steam-excavator, D. R. French, Westport, Wash. |
| No. 656,098. | Screen for stamp-mills, M. R. Driscoll, Frisco, U. |
| No. 656,949. | Cable conveyor, D. B. Cruickshank, Providence, R. I. |
| No. 655,478. | Ore mixer and sampler, J. M. Damm, Durango, Mex. |
| No. 656,204. | Safety device for mines, D. McCowan, Neihart, Mont. |
| No. 656,580. | Calcining or roasting furnace, A. E. Johnson, Victor, Colo. |
| No. 656,032. | Apparatus for electrolyzing ores, A. M. Rouse, Denver, Col. |
| No. 656,369. | Anchoring device for dredges, R. R. Osgood, Lansingburg, N. Y. |
| No. 656,674. | Ore-concentrating agitator, A. H. Stebbins, Little Rock, Ark. |
| No. 655,416. | Machine for separating rock-asphalt, J. Philippi, New York, N. Y. |
| No. 656,728. | Process of separating ores, H. C. Robinson, Cincinnati, O. |
| No. 656,893. | Apparatus for treating coal and ores, J. W. Kenevel, Chicago, Ill. |
| No. 656,279. | Self-acting mining-dog, W. A. Wilson, Murphysborough, Ill. |
| No. 656,048. | Endless conveyor, A. M. Acklin and W. J. Patterson, Pittsburg, Pa. |
| No. 656,067. | Hoisting apparatus, R. Watson and C. E. Stevenson, Nanaimo, Can. |
| No. 656,515. | Telescopic drill-shaft, I. N. Cassity and W. J. Cassity, Holton, Kans. |
| No. 656,544. | Process of treating gold and silver ores, H. Hirsching, Salt Lake City, U. |
| No. 655,292. | Mining drill, J. Wynne, Plymouth, and V. V. Haidacher, Wilkes-Barre, Pa. |
| No. 656,305. | Process of electrolytically extracting zinc from ores, W. Strzoda, Faltenze, Germany. |
| No. 656,268. | Process of treating ores for recovery of metallic ingredients, B. Sadler, Denver, Colo. |
| No. 656,103. | Miner's or camp stove, Wm. Forker and Wm. Mitchell, Glenwood Springs, Colo. |
| No. 655,430. | Apparatus for extracting and refining asphaltic material, A. F. L. Bell, Carpinteria, Cal. |
| No. 655,433. | Magnetic separator, C. F. Courtney and R. Butterworth, Broken Hill, New South Wales. |
| No. 657,030. | Process of extracting bismuth from ores containing bismuth oxides, etc., J. Ranald, London, Eng. |
| No. 656,497. | Process of treating zinc bearing complex ores for recovery of zinc or other metals therefrom, G. de Bechl, Paris, France. |

Mines and Minerals

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COAL MINES AT STREATOR.

An Interesting Description of the Important Coal Fields and Mines in La Salle County, Illinois.

Surface and Geologic Conditions—Plants of Chicago, Wilmington and Vermilion Coal Company—Electric Haulage—Star Coal Company's Mines and Methods—Rope Haulage.

Written for MINES AND MINERALS, by A. Dinsmore.

La Salle County on the northern edge of the great Illinois coal field, has a varied surface and is rich in mineral wealth. The Illinois River with its level now raised two feet by the waters of the Chicago Drainage Canal, divides it almost centrally. The Fox, Big and Little Vermilion Rivers, besides a number of smaller streams, all join the Illinois and make the drainage unusual for prairie land. High rocky bluffs and deep gorges along the Illinois, as well as the undulating surface, both north and south of this river, to the very border of the county, differentiate it sharply from any adjoining.

Coal underlies nearly the whole area, four seams, known as geologic numbers 2, 4, 5, and 7 all being represented, with an aggregate thickness of 16 feet. The great uplift which brought the oldest rocks in the state, the magnesian limestone of the Lower Silurian, to the surface at Utica, lifted the coal measures 400 feet, so that they overlie unconformably this limestone as well as the St. Peter's sandstone.

Of these seams of coal, the remarkable one is No. 7. It extends from this the northern part of the state, almost to its southern end, being found in Williamson County from seven to ten feet thick and outcropping on the Ohio River. The special economic qualities of this coal are a low percentage of fixed carbon and a correspondingly high percentage of volatile constituents, rendering it of notable value for steam making and domestic use. It was chiefly from this seam that more than 1,000,000 tons were mined last year in and about Streator.

This busy town is situated in the southern part of La Salle

County, on the high bluffs of the Big Vermilion River, whose yellow bed and water indicate the origin of its name.

The largest operator here is the Chicago, Wilmington and Vermilion Coal Company which is now working two shafts. No. 1 is about four miles from Streator at the suburb of Heenanville. This mine is worked by the three entry room-and-pillar system. It offers many features of interest, some of these due to its situation. The shaft is 92 feet deep and the coal runs out into four ravines. Entries have been worked out in these, so that now there are these natural escapes for the men, beside the air shaft which the law requires. The mules walk out of the mine through one of these escapes to their pasture at night. Here I may mention that another luxury connected with mining at this shaft is the special railway train of comfortable cars which takes the men from Streator to their work in the morning and carries them home promptly at 3:30 in the afternoon.

The land in the vicinity of the mine is so high that the water needed for the boilers, accumulates by drainage from the surrounding farms, in a pond near the shaft. The white oak used for timbering grows in the immediate neighborhood.

The seam of coal averages 8 feet in thickness, 2½ feet of this in places seem to belong to No. 5 rather than to No. 7; the two seams are usually together, but sometimes have half an inch of slate between them. The blasting is mostly "from the solid" with powder, the shots being fired at the noon hour and when the men leave for the day. Last year 5,754 kegs of powder were used. The coal comes out in blocks so large that often it is all

that two men can do to load one of them on the cars. These cars carry 3,500 pounds of "run of mine."

The coal is separated by a Link-Belt shaker screen into "lump," "nut," and "screenings," 40 per cent. being screenings. These are now taken from the screen to a building 250 feet away to be cleaned by the Illinois Coal Washing Company. The coal is carried on a sprocket chain 500 feet long with "flights" 18 inches apart to bins placed over 4 Forrester jig washers. These stand side by side at a height of 40 feet above the ground. The washers are built of wood. A wooden plunger mixes the coal and water as they fall together into the washer. The coal, owing to its light specific gravity, passes on the top of the water into a trough below the washer, while the slate and soapstone refuse fall below into a

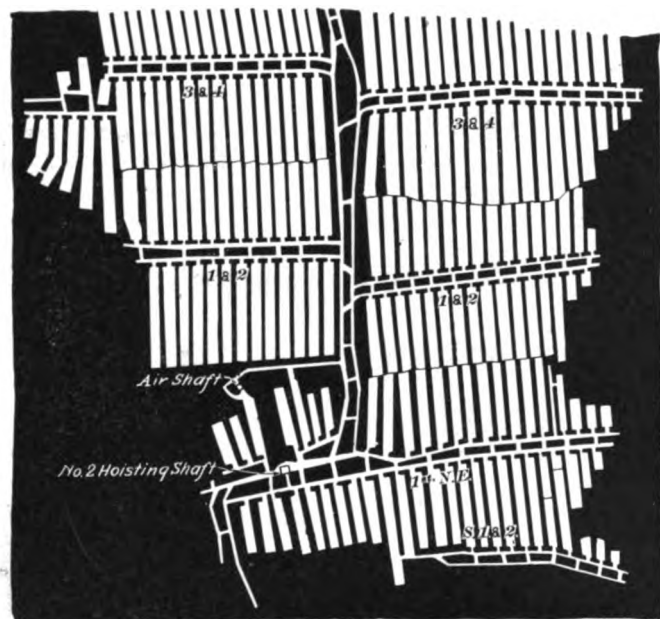


SHAFT NO. 2, STAR COAL CO., KANGLEY, ILL.

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bin. As the washed coal is taken on another sprocket chain from the troughs, fresh water falls in a number of jets upon it, to rinse it. Then it is carried to the draining piles at the top of the building, whence it falls into cars ready for shipment. The capacity of each washer is 150 tons in 8 hours. Ten men are employed in operating the four washers.

The mine has been worked for 6 years, and somewhat more than 200 acres of coal have been taken out. The average day's



PLAN OF NO. 2 MINE, STAR COAL CO., KANGLEY, ILL.

work of the 370 miners now employed in not quite 4 tons per man. The miners represent several nationalities; a large number are Slavs from Russia and the Balkan States. This may explain the fact that the beautiful Greek church which was a part of the Russian exhibit at the world's fair in Chicago, is now in Streator.

At the Chicago, Wilmington and Vermilion Company's Shaft No. 2, mining seems to be carried on with the minimum of hard labor and the maximum of comfort and safety, so far as old time conditions are concerned. Electricity has largely taken the place of oil lamps and of both man and mule power.

"The mine," to quote its manager, Mr. Keating, "is shaped like a shoestring." Furthermore, it is at very different levels in different parts. The workings dip 20 feet in 600 in one section and 12 feet in the same distance in another. In the steepest place, the grade rises one foot in nine feet. The mine is worked both north and south from the shaft. The north side falls 21 feet in the first 600; then for the next 600 feet it rises until it is 31 feet above the bottom. Then it dips, till it is only 5 feet above the bottom; 700 feet east, it falls 5 feet below the bottom. Besides all these changes of level, a sandbar from 50 to 170 feet wide divides the mine into two parts. This is probably the bed of an ancient river. It is tunneled to connect the two sections of the mine.

In such a mine, haulage was necessarily a very serious problem, now successfully solved however by electricity. Two electric motors, one at the north and one at the south working are flying back and forth between the shaft and the ends of the main entries, each making the round trip of more than a mile in from 7 to 9 minutes and drawing 14 loaded cars of coal at a time. These motors are made by the Goodman Manufacturing Company, of Chicago. Their motion is so steady and the track is so well constructed that the cars are loaded two or three feet above the top. The motors run with a trolley attachment, the overhead wire being placed not between the tracks, but over the one next the wall. The approach of a train, especially from a point near a declivity, is a strange spectacle: on such a down grade, sand is sprinkled on the rails to increase the friction and the wasted electricity streams up in flames from 2 to 3 feet high, as if to herald this noisy, terrifying monster rushing out of the far gloom. I say *gloom*, because though the main entries are strung with electric lights they are not luminous or powerful enough to relieve the distant darkness.

Only two men are required to manage the long electric train, one riding on the motor, and the other on the rear car. These men are taken from the ranks of the miners.

The main entries are so high that the wires do not endanger a man of ordinary height, and are wide enough to allow for another track beside the trolley tracks. On this the men generally walk and the mules travel at night when taking in timber. The haulage in the side entries which are 7 feet wide, is entirely by mules.

This mine, like all the No. 7 seams is worked by the room-and-pillar system. It is 116 feet deep at the shaft; the coal is about 6 feet thick. The roof is of rather fissile soapstone which is specially likely to break when the weather is warm; great care is taken to prevent accidents from the falling laminae.

A good deal of water has to be bailed out of the mine. This is done by four men who lift it in buckets into a water car in which it is hauled to one of 3 sumps; from them it is pumped by an electric pump on the south side of the mine. An electric pump is now being put in place at the north side. But the water has yet to be lifted to the top. This is done by a Wells pump of 26 inch steam cylinder and 18 inch water cylinder, and a Blake pump of 24 inch steam and 12 inch water cylinder. The water cannot be used in the boilers, which are supplied from the Streator mains only two miles distant.

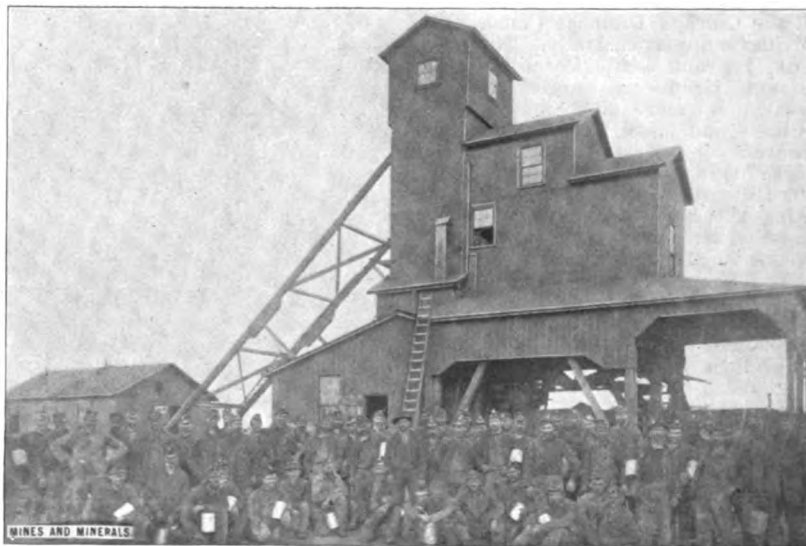
The capacity of the pit cars of which I have said, 14 are drawn at once by the electric motor to the shaft, is 3,500 pounds. In these the coal is lifted to the top of the shaft by the hoisting engine, and there falls into a hopper. The contrivance for opening the cars is worth noting. Their ends are on hinges; a hook suspended from a timber in proper position, catches a strap on the end of the car as it comes to the top landing, opening it automatically as the car tips, and thus the contents are emptied into the hopper, from which they fall upon a Link-Belt shaker screen, to be separated as at the other mine. Some of the slack is carried over to that shaft to be washed. The weighing is done as the coal falls into the hopper, by means of a Fairbanks Morse & Co's automatic quick-weighing attachment.

The air in the main entries of this mine seems as fresh as in the open. A fan 10 feet in diameter is revolving 160 times a minute at the top of the air shaft.

The power for the whole plant is furnished by 5 boilers each of 66 h. p. capacity. The dynamos of 600 amperes capacity were built by the old Sperry Company, and are run by an Ide engine, made in Springfield, Illinois.

The output of this mine is now about 1,200 tons a day, taken out by 390 miners. The total tonnage last year was 329,069 tons, against 372,433 tons at Shaft No. 1.

A description of this company's new and finely equipped mine in geological formation, No. 2, at South Wilmington, Grundy



SHAFT NO. 2, CHICAGO, WILMINGTON AND VERMILION COAL CO., STREATOR, ILL.

County was published in "MINES AND MINERALS," in October, 1899. The name of the flourishing town that has grown up near that shaft has lately been changed to Lawton.

The Star Coal Company is second only to the Chicago, Wilmington and Vermilion in the extent of its operations at Streator. It has been mining since 1877 and has worked out four mines. At present it is running four mines at Carbon Hill, in Grundy County, in No. 2 seam, and has just put down a new shaft to the

same vein 210 feet from the surface, at Kangley, four miles northwest of Streator. No coal has as yet been taken out here, for being in No. 2 seam it must be a "longwall" mine, and miners who work by this system are not now to be had in this locality. But only a few yards from this shaft is the company's No. 2 mine which is in operation. Nothing could be more convenient than its situation, for the station, Kangley, on the Chicago, Burlington and Quincy R. R. is but a few feet from the mine. The property has lately been improved by having a new air shaft at its north workings and by a connection with an old shaft at the west. From one natural escape where the coal has been taken out to the surface, the men walk out and eat their dinner under the trees.

The feature of special interest in the working of this mine is the rope haulage in the main entries. This endless rope runs at the rate of 3 miles an hour by power from an engine at the bottom, directly under the boiler room. To this engine, the steam goes down through a drill hole 60 feet from the shaft. The rope requires no attention when once it has been started by the pumpman in the morning until noon; then it is oiled and runs on till quitting time. The company has just put in 8,000 feet of new steel cable of $\frac{7}{8}$ inch diameter. It is composed of 19 wires to the strand and has 6 strands. Experience has proved that fine wire wears better than coarse. The rope is wound on an iron drum and also upon a Walker wheel in front of the engine, and three feet from the drum. This system of haulage in addition to mules in the side entries, is necessitated by the shape, size, and irregularities of surface in the mine. It is 86 feet deep and worked by the two entry system. In the 14 years since it was opened 500 acres of coal have been taken out. A sandbar 160 feet wide in places, has

THE "DOWN TOWN" MINES

Of Leadville—An Account of Their Development and the Changing of Leadville From a Silver to a Gold Mining Camp.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

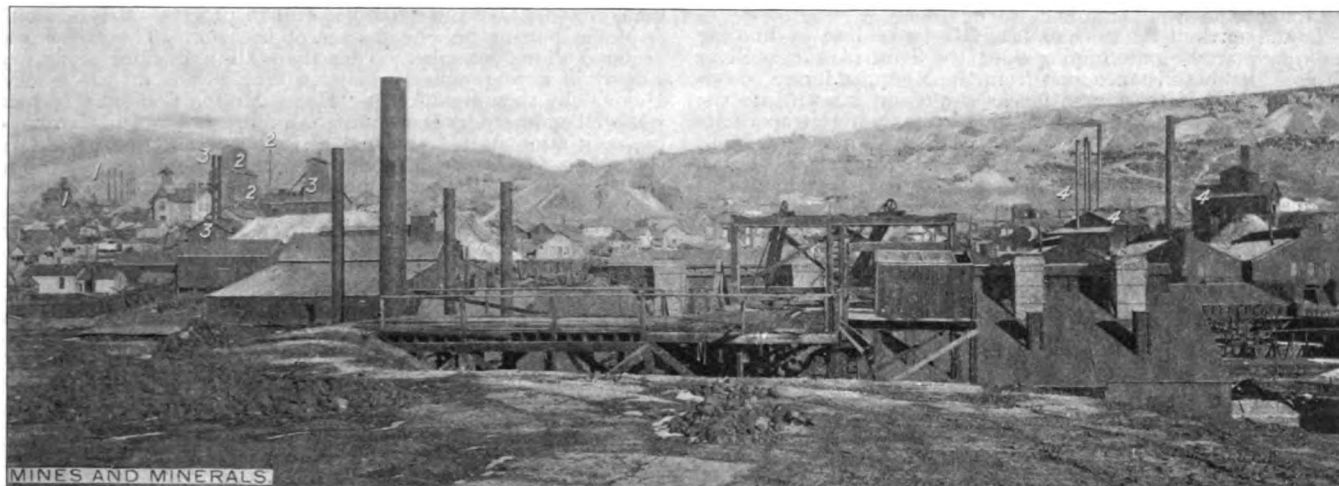
We remember some years ago camping on the site of the present Leadville, and starting a deer not far from the location of some of the afterwards noted mines. Placer mining was going on then in "California Gulch" but that was all the mining there was. "Heavy rock" thrown out of the placers as a nuisance proved to be carbonate of lead. It was quickly traced to the ledges whence it came.

A few months after we paid a second visit. Leadville or the "Carbonate Camp" was then born. Prospectors by hundreds and thousands were scattered over the hills, and men were hurrying here and there with boards over their backs rigging up the first shanties of the young town.

Later we visited the Camp a third time as a member of the U. S. Geological Survey, when Messrs. Emmons, Cross, and Jacobs were engaged in unraveling the complicated geology of the region with its wonderful intrusions of porphyry and its numerous and profound faults; a very necessary work to aid the miner in his locations and mining operations.

Again, years after, we visited Leadville to find it had changed with depth from a superficial carbonate ore camp to a sulphide one. It was still, however, emphatically a silver-lead camp, though it had changed from carbonates to sulphides.

We paid a short visit after the slump in silver, and found on



THE "DOWN TOWN" MINES, LEADVILLE.—1, Penrose; 2, Star; 3, Bohn; 4, Bon Air.

been tunneled. In this pieces of timber of such size were found as to indicate that it was once the bed of a river. "When the miners struck the sandbar, water flew like cider from a barrel," said the superintendent. This great volume of water was disposed of by digging a ditch for its escape.

Four boilers furnish the power for the haulage and hoisting engine, the belt pump and the fan. The water used in them comes from Spring Lake a mile and a half away.

No. 7 vein averages in this mine from $5\frac{1}{2}$ to 6 feet in thickness, though in places it measures 12 feet. The present output is 500 tons a day. The entire output for the year ending July 1899 was 149,137 tons.

For the same year the Acme Company and William Howe and Co. both operating at Streator, produced respectively 86,166 tons and 55,686 tons, from the No. 7 seam. Besides these, there are about a dozen other private companies mining here in the same seam, using horse or hand power, and doing a team trade.

For the information and very courteous attention received at Streator while visiting the mines, I wish to express my acknowledgments to Mr. W. S. Cherry, Superintendent of the Chicago, Wilmington and Vermilion Company, and to his mine managers Mr. Robert Jordan and former State Mine Inspector James A. Keating, also to Mr. C. H. Rathbun Superintendent of the Star Coal Company.

The contract for pumping the water from the Comstock mine has been completed and the water has been lowered 386 feet below the Sutro tunnel. The Evans system of pumping which was used is said to have worked very satisfactorily.

the southeast end that a portion of the Leadville district had accommodated itself to existing financial circumstances and needs by changing into a gold-belt camp. The "Little Johnny" or "Ibex" had found at a certain horizon very nearly coincident with the silver belt that a zone of oxidized porphyry carried an extraordinary amount of free gold, as well as sulphides containing gold, and borings as well as shafts were being put down over that area in search of the continuity of the gold-bearing zone.

And now again, recently, we have visited the far-famed camp, our object being mainly to see and study what have been called the "down town" mines.

For a long period of Leadville's history mining operations were confined more or less to the Mosquito Range, east of, or back of the town, which covered some square miles along the flatter portion at the base of the hills, and upon the moraine mesas extending down from the "Mosquito Range" into the broad Arkansas Valley. But few mines transgressed from the hills into this "down town" portion. The U. S. Geological Survey maps showed that there was a probability of ore bodies existing in the strata even under the very streets of the town, and several so-called "down town" shafts were put down; the experiment proved successful, and the ore bodies, as well as the ore-bearing strata, were found continuous beneath the city, but with the ore was found also a vast amount of water. The success of some of these "down town" undertakings led to the question as to how far to the westward or underneath the broad Arkansas Valley, hitherto condemned as sterile, the ore-bearing strata might extend. Could it underlie the valley generally, or was its continuance from the Mosquito Range abruptly terminated by a fault such as the most westerly or Carbonate fault? Or, again,

if the strata did once continue westward even to the base of the opposite Sawatch Range had it not all been scored away by the great glacier that once occupied the Arkansas Valley, and might not its place on the top of the underlying granite have been replaced by the heavy and deep morainal matter which the glacier dropped on its retreat and melting? As the whole valley was a plain entirely and deeply covered by morainal drift there was no way to solve this question except by practical experiment by shafting and boring.

From a theoretical geological point of view we have reason to believe that the ore-bearing strata now forming the Mosquito Range once extended to the base of the Sawatch Range. We know that from Cambrian to Carboniferous times the ancient seas laid down strata from the Colorado or Front Range, now forming the eastern rim of South Park, to the Sawatch Range, which was then a huge granite island in the Paleozoic Ocean, that these strata, whilst at first lying horizontal, were penetrated by intrusive sheets of porphyry bringing metallic matter with them, and that later the shore-line strata with thin included porphyries were folded up into the range called now the Mosquito, and in process of folding were severely faulted by a series of step faults more or less parallel with the trend of the range. Subsequent erosion and glaciation left the country in the condition of today. Seeing that the Sawatch was evidently the western shore line of this Paleozoic sea it is remarkable that we do not find any sedimentary strata resting on or upon its flanks. We can only account for this on the hypothesis either that such strata were scored away by the Arkansas glacier, or that the eroded stubs of it are deeply buried along the flanks of the Sawatch Range, or that by some later movement of the range a profound fault along its flanks has carried such strata down out of sight.

To the north of the town of Leadville two miles, we find the Cambrian quartzite outcropping along the South Arkansas River at a considerable distance west from the Mosquito Range, showing its farthest extension so far as at present known into the Arkansas Valley. Resting on the top of this Cambrian quartzite is a thickness of about 500 feet of material which may all be drift matter or it may contain other members of the Paleozoic series, such as the ore-bearing Carboniferous limestone; this has to be proved by shafting or boring. This is the only clue and proof of western extension of the ore-bearing strata we have to the north; the interval of several miles to the south towards the city gives absolutely no clue, all is apparently surface drift. To the south, in the vicinity of Malta, we have granite, and at the town of Granite this rock outcrops boldly and unmistakably with no sedimentary rocks resting on it. The interest there now centers in taking the Carbonate fault as our absolute eastern limit, and from it creeping gradually by a series of experimental shafts and boring out into the Arkansas Valley, and finding out tentatively whether the ore-bearing strata exists below it and how far westward it extends.

To prove this important point which may result in nearly doubling the mining area of Leadville, and so doubling the size and value of the town, has occupied for a long time the energies and enterprise of Major A. V. Bohn in face of the ridicule of many, and even of the grave opinions of those well competent to form an opinion. He was convinced that the ore-bearing strata extended beyond or to the west of the Carbonate fault, which by geologists and general consensus had been determined as the greatest possible western limit. He put down shafts himself and interested others in his project to put down more, the result has been that ore bodies and strata have been found in full force for a considerable distance west of the Carbonate fault limit, and it is only now a problem how far west these successes may extend, a question which is a most attractive one for future experiment.

The first start in testing Mr. Bohn's views was by him on the Lucy B. Hussey shaft of the Wolcott Mining Company ground, located about 200 feet west of the Carbonate fault. At a depth of 200 feet the well recognized iron and manganese was found dipping eastward, and carrying some carbonates in pockets. Next adjoining on the west, Mr. Campion took up some land and on the Elk claim, also struck "contact" and got good ore at a depth of 250 feet. This shaft was still 400 feet west of the Hussey. Then Major Bohn himself continued the western extension for 500 feet beyond the Elk fault and sunk a shaft whose results greatly discouraged them as they thought this fault must certainly mark the extreme western limit of the ore-bearing strata. Major Bohn then dropped down to the Penrose, still west of the Elk fault and shaft, some 1,200 feet. First he shafted down through 318 feet of moraine matter, and then he put down a diamond drill for 145 feet and struck the overlying white porphyry, then 36 feet of shale, 9 feet of contact matter and 70 feet of "blue lime," total 260 feet at this point, satisfied at having struck the right formation, drilling was discontinued, the shaft was sunk 500 feet, 300 feet being added. There was a total in the shaft of 500 feet from

the surface to the top of the lime. Then he began drifting. The presence of the porphyry and lime fully satisfied him that he was on the right zone, and he then went to regular mining, encountering at first large volumes of water.

Then Messrs. Smith and Moffat took hold, next Mr. Bohn started on the Lazy Bill, now part of the "Star" mine. This drill-hole went down 570 feet. The location of the drill is 400 feet from the Penrose. Nine feet of ore was cut by the drill in one body, but this has not yet been reached by the shaft. From this experiment Mr. Bohn went on to the Bon Air which is 1,630 feet west from the Penrose, thus ever extending the area of experiment westward. The same geological features were met and at 500 feet from the surface 8 feet of good ore was encountered.

The first work was in 1891. The present Bohn shaft and Valentine shaft are alongside one another. The Bohn follows the Bon Air to the west. The panic of 1893 stopped the whole business. The Penrose and Bon Air were then both shipping and proving satisfactorily Mr. Bohn's theory. In 1894, after recovering from the panic, Major Bohn procured the ground named after him and sunk the Bohn shaft without previous experimental drilling. The following was the character of the ground pierced: 252 feet wash or glacial and lake-bed matter; 74 feet white porphyry; 20 feet Black porphyry; 45 feet Birdseye porphyry; 75 feet "blue limestone."

In this dolomitic Leadville limestone the ore was found, and the Bohn mine soon became a heavy shipper.

The miners' strike of June 16, 1896, stopped everything and killed Leadville for nearly three years. The mines very soon became full of water owing to stoppage of the pumps and remained so till a pumping association was organized in 1896, which put up \$50,000 for unwatering the mines. This was inaugurated whilst the strike was still in progress, Messrs. Smith & Moffat putting up one-quarter of the sum. The strike was declared off in September. Then there was a dragging along and a delay of a year, nobody being willing to put up the money. Major Bohn then organized a "Home Mining Company" which was well endorsed by the leading Leadville papers, and the pumping association started the first of October, 1898, and unwatered the mines. This company included the "Home Mining Company" and several other companies' properties.

After the pumping association declared the mines unwatered on the first of August, 1899, each party took possession of its own mine. It was then the Home Mining Company got possession of its properties, viz.: the Penrose, Star, and Bon Air, and capital was put into the development work. The mine for eight months carried its own expenses, including opening and re-timbering and new development. All this was paid for out of the product of the mine. The mine has paid 150 per cent. dividend up to June 1st, 1900. It has at least 50,000 worth of property, including pumps and machinery. Lately Mr. Bohn's son, believing in the theory of his father, went still farther West and put down the Valentine shaft 2,500 feet from the "Bon air" to the southwest. So far he has gone down through 312 feet wash; 118 feet porphyry; 3 feet contact matter; 54 feet limestone; total 487; thus proving the westward continuity of the formation. Mr. Bohn estimates the area as three miles wide towards the west from the Carbonate fault, extending from the City of Leadville 12 miles to the north and 8 miles to the south, an area approximately 15 X 15 miles or a total of 608 square miles.

VISIT TO SOME OF THE "DOWN TOWN" MINES.

The first mine we visited was the Penrose, one of the prominent "down town" mines, just on the western edge of the city. It is equipped with a 100 H. P. hoister with drums 72 in. X 36 in., cylinders 14 in. X 16 in., round rope one inch diameter 1,000 feet on each drum, and provided with a Lane clutch. The present depth of the mine is 540 feet. Water was met at 200 feet, giving 400 gallons per minute. This is controlled by a Knowles compound duplex condensing pumping engine. Snow pumps are used as sinkers. There are two of these with capacity of 1,500 gallons per minute. The Coronado moves 300 gallons and at different places 3,000 gallons per minute are raised. Snow pumps are rated as throwing 750 gallons each from 500 feet depth. The Snow pump has two cylinders, duplex tandem, giving speed power at any depth. The water runs down the street to the Arkansas. There are nine boilers, two 100 H. P., six 80 H. P., and one 60 H. P.

Besides the hoister mentioned there is a Webster, Camp & Lane No. 2 reel with flat band 4" wide rope; the diameter of the reel is 7 feet. We found here, as in many of the other mines throughout the West, that the flat band or flat rope system is being abandoned and they are returning to the old-fashioned round rope. One cause of this seemingly retrograde evolution is due to the great weight of the rope in hoisting.

On descending into the mine we were struck by the terrific amount of crushing of the stulls and pillars by swelling of the

overlying white porphyry. This crushing occurs in almost all the Leadville mines, and is only surpassed in the deep mines of Butte, Montana, and some at Aspen, Colorado. Pillars 18 in. diameter of squared timber were crushed into kindling wood, and lagging was often bulging outward and snapped. When a man begins to think of opening up a mine and counts up the cost of timbering, it is well for him to consider this item of crushing and consequent repairs and re-timbering.

The ore occurs as masses of black manganese and iron lying immediately under the overlying white porphyry, replacing the dolomitic limestone that lay below it. This body of manganese and iron carries more or less silver. Occasionally rich patches of lead carbonates occur and now and then unoxidized patches of galena.

A notable feature in the mine is the white dolomitic sand in the drifts; another striking and interesting feature are the holes or water channels descending into the drifts, some of them large enough for a man to crawl into. It was through these channels, now dry, that the mines were flooded and so long remained full of water; they seem to come in from a northerly direction and are quite common in the various drifts. They too doubtless aided largely in bringing in the white dolomitic sand which came in in such volumes that after the mines were unwatered the drifts were found packed hard and solid with them and had to be opened anew, often a very difficult undertaking owing to the flowing in of watery material, like a quicksand. In some places piles had to be driven in to head off the work and excavations made underneath them.

After the Penrose we visited the Star mine, here they have a Fairbanks, Morse & Co. friction hoist with a cylinder 12" x 16", and with a 1 inch rope. The developments of this mine are very similar to the Penrose. Thence we walked westward to the Bon Air mine, celebrated as the scene of a notable accident in which a large portion of the surface of the mine collapsed and shut in the shafting, imprisoning for several days a number of men, but fortunately not killing them or entirely shutting off their air supply. Signals and communications were made with the surface and food lowered them, and they were kept alive for several weeks until a rescue shaft could be run down from the surface to reach them.* This shaft is visible on the dump outside the plant. The collapse was caused by seepage of surface waters. To temporarily avert further outflow of material, great quantities of hay and straw were thrown in and found successful.

A long, high trestle bridge runs out from the mine, dumping the ores by a series of wooden aprons on either side the track to the cars below. The isolated aprons at intervals are not considered so good as one continuous sloping apron on either side along the trestle. From the top of this trestle bridge above the mine we have a fine view of the region west and of the Arkansas Valley, bounded on the west by the magnificent snow-capped Sawatch Range with the Arkansas River flowing parallel with it not far from its base. It is this area that is now the center of interest as to its possibilities of being underlaid with ore-bearing strata. We can see steps advancing towards the solution of this great problem by the outlying shaft of Mr. Bohn's son, and by the Maple Street shaft. These are on the fore front of the bold prospecting line, although we saw the commencement of a shaft by Mr. Bohn some way below Malta which had not as yet reached any solid foundation.

Another well-timbered shaft was being put down on Capitol Hill near the north end of the principal street of the town, and at the time of my visit there was hourly expectation of striking the solid formation; so far they had only penetrated through drift and lake-beds.

Besides these frontier or prospecting line "down town" mines, we visited some of those farther up in the city, such as the Midas and M. A. B.; these are right in the heart of the town and by the side of the principal streets, their dumps carefully timbered up beside the roads. These mines with depth have been found to contain large bodies of manganiferous iron, carrying silver and some lead, as well as a great amount of water. They seem to be located in a shallow synclinal basin, as the strata are found dipping towards a common center, and over 500 feet of drift and lake-bed fills the upper portion. The ore occurs below the porphyry, replacing by substitution the underlying limestone. All these "down town" mines are connected by workings; their main trouble is water, which is controlled by large Knowles pumps, pumping 1,000 gals. per minute into tanks and up to the surface. A Snow pump is also used for the lower workings and at the A. M. W. mine the shaft is 970 feet deep. They are using a reel and flat band hoist at present. The water is pumped up by triple expansion pumping engines with high pressure cylinders 20 inches in diam.; intermediate 34, low pressure 44, 36 inch

stroke, 10½ in. plungers, built for steam pressure of 150 pounds. There are 7 boilers, each of 100 horsepower and carrying 150 pounds of steam.

The Midas and M. A. B. are severally 550 and 1,000 feet deep, pumping 150 gallons per minute. They pay their pro rata of pumping to what is called the Pump Association. Individual mines generally do their own pumping. It would be a great boon if these up and down town mines could be unwatered by a long drainage tunnel, starting in from the Arkansas Valley, but the conformation of the ground will not admit. The greatest depth that could be attained by such a tunnel would not exceed 500 feet, and many of the mines are far below that.

Another item that will have to be considered in future developments of "down town" mines will be dumpage room right in the populous part of the city.

THE YAK TUNNEL.

As an example of a drainage and exportation enterprise we visited the celebrated Yak Tunnel, which is down under Iron Hill, and whose ultimate goal is the distant gold-belt of Breece Hill and the Little Johnny and Ibex Company's mines. For the first nine hundred feet you pass under a covered shed-way before entering the solid rock. This rock consists of red granite, quartzite, porphyry and Paleozoic limestones. Much of this is timbered with heavy timber and in some places with lagging. Most of the well-known Leadville formations are cut at a slight dip and several faults are passed. Ores are found at the usual contacts. A good deal of the latter part of the tunnel is in red granite. We pass on our way two or three side tunnels and workings which have come down from the Silver Chord, and other mines. There being but little dip to the strata comparatively few different formations or ore deposits are encountered by the tunnel, and at present far less water drains out than might have been anticipated. On one of the side tunnels they are sinking and taking out ore with small handy little hoisting engines, driven by compressed air only, which are often used inside some of the Leadville mines. The success of the Yak Tunnel will largely depend upon when it reaches and underdrains as well as exports from the Gold-belt region, which it will tap at considerable depth. At present a length of 8,500 feet has been attained.

A VISIT TO THE "RESURRECTION" MINE.

A visitor who remembers Leadville in its earlier days, when silver was at its height will be struck as he rides towards the Mosquito Range with the vast amount of huge dumps and big works that at present are for the most part idle. These mark the sites of many of the well-known and once celebrated old silver stand-bys that made Leadville in early days celebrated. Such monuments would have at first a depressing effect were it not for the great amount of young and very valuable mines that have sprung up, in some cases as it were from the roots of the older ones and in others in new and more extended portions of the Leadville field from which little was once anticipated. We have in this connection the "down town" mines on the one side and the Gold-belt mines on Breece and Little Johnny Hills on the other, but these are not all, for from the latter again a systematic prospecting has extended the gold-belt and ore-bearing area over many unlooked for parts. A prominent example is that of the "Resurrection" group. This lies on one of the faulted step-like blocks of the westerly flank of the Mosquito Range, on the edge of an amphitheater in whose lap lie glacial lakes supplying Leadville with drinking water. As we pass along the hill sides, we look up on Breece Hill on the right and see the great yellow dumps of the Little Johnny, like so many piles of yellow sawdust from a monster saw mill. The Ibex, Little Johnny and Breece Hill mark the line of the so-called Gold-belt, while on a humbler hill, called Little Ellen below is the Resurrection, its works crowning the hill, surrounded at various levels by a number of mines on the same belt. As the strata dip from the Resurrection down to the amphitheater several of these mines are on the flat below.

The succession of strata through which the main shaft goes are first a few hundred feet of Weber grits and shales, then white porphyry, then blue limestone. The ore occurs in the limestone as well as at the line of contact with the porphyry. It consists of iron oxide and lead carbonates, carrying a certain amount of gold with the lead and silver, below this is the parting quartzite, about 25 feet thick, and below this is Silurian limestone in which some gold is found. The shaft is down about 1,000 feet. There is a good deal of water in the lower portion which is controlled by powerful pumps. The mine is heavily timbered, and the drifts meander through it. There is the same great strain on timbers shown here as elsewhere in Leadville. The ore is a good smelting ore on account of the carbonates of lead which it carries, but there is a great deal of siliceous matter with it.

* See Mines and Minerals, Vol. XIX, p. 459.

THE MESABI RANGE.

A Description of the Ore and Also of the Open Pit, the Caving and the Milling Methods of Mining It.

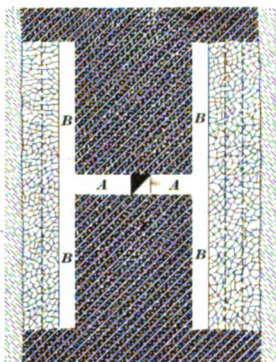
By Cyril Brackenbury, M. E.*

The Mesabi range in the state of Minnesota is a low range of hills running a little north of east and south of west and lying about 60 miles northwest of Duluth. It is separated from the Vermilion iron range on the north by a granite ridge, which is called the Giant's range.

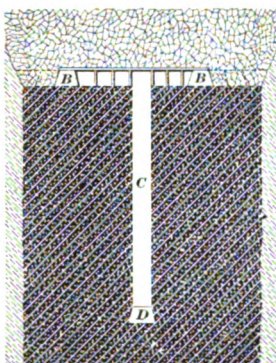
The ore bodies lie on the southern slopes of the low hills which form the Mesabi range. Near the Giant's range, the dip is steep, but it flattens out almost to a horizontal away from the granite. These deposits occur in lenses, which sometimes form

basins, and vary from a few feet to three or four hundred in depth. At the Oliver mine a drill hole has shown 335 feet of ore. The ore bodies generally lie in a south-easterly direction, and often attain several thousand feet in length, though usually only a few hundred in width. The dip is slight and generally inclines to the south.

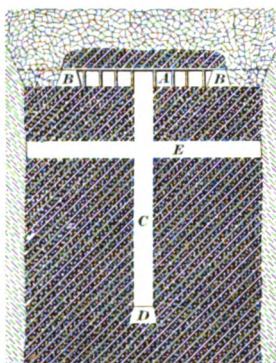
The ore-bearing rock is a jaspery chert called "taconite," which is found, broadly speaking, under the black slates called "animikie," and



(a)



(b)



(c)

PLAN AND SECTION SHOWING CAVING METHOD.

over the Pewabic quartzite. The whole region is covered with glacial drift, which varies from a few feet, to over one hundred feet in depth, and the ore bodies are found under this, an outcropping rock being a very rare occurrence.

The ore is dark red, brown, or blue, and of a soft, earthy texture with some hard streaks running through it. It consists chiefly of hematite and the blue ores are generally the richest in iron and most free from phosphorus. The ore "in place" averages about twelve cubic feet per ton, or about 18 cubic feet of loose ore per ton.

The ore deposits are thought to have originated by the replacement process, the taconite having been dissolved out by water containing carbonic acid, some of which may have been taken up from the rock itself which contains calcareous streaks.

carbon dioxide passes on into the rock and aided by pressure readily dissolves iron. The water becoming saturated with iron, then passes into a zone of oxidation, such as a fissure, the excess of oxygen and the release of pressure cause the ferrous salts to be oxidized and deposited while the silica is attacked and removed by the alkaline solution.

The two principal companies owning mines on the Mesabi Range are the Minnesota Iron Co. and the Lake Superior Consolidated Iron Co. Each of these companies controls a railroad, and has its own steamers, which transport the ore to the lower lake ports. The Minnesota Iron Co. controls the Duluth & Iron Range railroad, which carries its ore to its docks at Two Harbors on Lake Superior, in which place are situated the company's railroad shops and chemical laboratories. The Lake Superior Consolidated Co. controls the Duluth, Mesabi & Northern railroad, which carries its ore to the docks in Duluth.

The proportion of iron ore taken from the Mesabi range, as compared with that obtained from the Marquette, Menominee, Vermilion and the Gogebic ranges, has increased annually very rapidly since the year 1892, when the Mesabi range commenced shipping with 4,245 tons from the Mountain Iron mine.

The following table will show the relative increase of ore shipped from the Mesabi, as compared with that shipped from the other ranges for the years 1892 to 1899 inclusive, and also the total ore production from each range from the first year of its shipment:

From this table it will also be noticeable that the shipment from the Mesabi range in the year 1899 was nearly twice that of the Marquette range, more than twice that of the Menominee, and also of the Gogebic, and more than three and a half times that of the Vermilion range.

In the year 1899, the Mountain Iron mine and the Fayal mine each shipped over one million tons of ore. On the Mesabi range the Minnesota Iron Co. is only shipping from four of its mines this season, namely, the Fayal, Genoa, Elba and Auburn.

The mines on the Mesabi may be divided into three general classes, namely: (a) open pit (b) underground and (c) mines which are a combination of the two preceding classes having part of their workings underground and part open pit.

The general method of open pit mining consists in first stripping off the surface glacial drift by means of steam shovels and loading it into cars and then attacking and transporting the ore itself in the same manner, having first loosened it up by blasting. As soon as a sufficiently large area of the surface deposit has been removed, then the first cut is made in the iron ore itself, the



DRIFT READY TO CAVE.

GROSS TONS OF ORE SHIPPED.

Name of Range.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	Total Production.
Mesabi	4,245	613,620	1,793,052	2,781,587	2,882,079	4,275,809	4,613,766	6,926,384	23,590,543
Marquette	2,666,856	1,835,893	2,059,330	2,097,838	2,604,221	2,715,035	3,125,039	3,757,010	56,135,271
Menominee	2,261,499	1,466,197	1,137,919	1,923,798	1,560,467	1,937,013	2,522,265	3,301,052	30,754,758
Vermilion	1,167,650	820,621	948,513	1,077,838	1,088,090	1,278,481	1,265,142	1,771,502	18,535,360
Gogebic	2,971,991	1,329,385	1,809,468	2,547,976	1,799,971	2,258,236	2,498,461	2,795,856	28,341,340

The process is thought to have taken place somewhat as follows: Atmospheric waters containing carbonic acid and some alkaline salts penetrate the rock and oxygen is taken up by unoxidized elements in the rock, causing carbon dioxide to be set free. The water thus free from oxygen, but highly charged with

stripping being continued and the area of ore exposed being constantly enlarged. After the first cut in the ore has removed a large enough area, the second cut is made, the first cut and stripping being still continued outwards. This process is continued, a new cut being made whenever a sufficiently large area has been uncovered by the last cut. The height of the stripping bank varies according to the depth of the surface deposit, and where

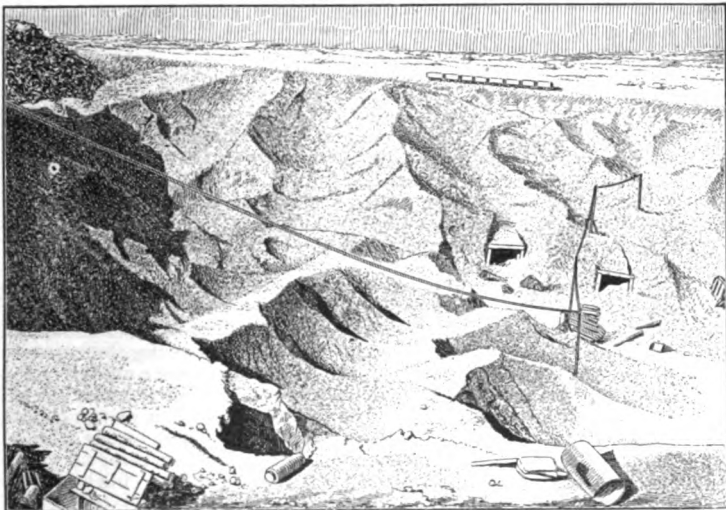
*Reprinted from the Daily Mining Gazette, Houghton, Mich.

the surface deposit is deep it necessitates more than one cut being made to remove it and to uncover the ore. As a general rule 25 or 30 feet can be conveniently removed by the steam shovel in one cut.

The Mountain Iron mine on the Mesabi range is a good example of a purely open pit mine. Here the topography of the deposit is well adapted to this method of mining. The water is removed by natural drainage through a ditch about 12 feet deep, made at the side of the track in the Rathbun cut. The outlet for the loaded cars has grades opposing the loads, as is of course generally necessary in this method of mining. Two locomotives are used for each steam shovel, one to handle the empty, and one the loaded cars. The only delay, therefore, that necessarily occurs is when the shovel is moved forward. Some great records in steam shovel work have been made here. The best record with the largest shovel is said to be 171 26-ton cars, or 4,446 tons in 10 hours. A shovel crew consists of five pit men, an engineer, a cranesman, and a fireman. The ore is first loosened by blasting before being attacked by the shovel. The ore is classified into different grades according to the percentage of iron and phosphorus. In order to do this the banks are carefully sampled from 25 to 50 feet ahead of the shovel, depending upon the kind of ground, and the results are used to guide in loading the cars. Samples are also taken of every trainload, and of cargoes if necessary.

There are several methods in use for working underground mines; often more than one method being used in the same mine. The Genoa iron mine belonging to the Minnesota Iron company is at the present time a good example of a purely underground mine. Many mines on the Mesabi range have originally started as purely underground workings, but have later done stripping and become mines of the third class in which both underground and open-pit mining are carried on at the same time. The Fayal mine, one of the best properties of the Minnesota Iron company, is now on this list, having been worked, however, until 1898 as a purely underground proposition.

At the Genoa mine the method of mining now employed is what is known as "sub-drifting and caving" method. This method may be briefly described as follows: First the hoisting shaft is sunk to the bottom or main level at an angle of 66 degrees, and in some cases a vertical timber shaft is also sunk to the bottom. Then the main level is blocked out by drifts. Upraises are made through the ore body, and chutes placed at the bottom.



OPEN CUT MINE WORKED BY MILLING SYSTEM.

The sub-levels are then started, only every alternate sub being connected with the timber shaft, and generally only the main level with the hoisting shaft. The sub-levels are about 12 feet apart vertically. The top sub is first blocked out with drifts, and then the blocks or pillars of ore removed by slicing back towards the shaft and the surface is allowed to cave in, the floor being first covered with rough inch boards as each drift and slice is made. By slicing is meant a series of short drifts run through the pillar to remove the ore from it, each slice being timbered in the same way as the drifts which were made in blocking out the level.

The ore from the slices is taken to be dumped in the chutes, either by means of wheelbarrows or tram cars, according to whether the place being worked is near to, or far from the chutes. In the Genoa mine the raises for the chutes are placed 50 feet apart, and in the Fayal they are 100 feet, consequently in the Genoa wheelbarrows are chiefly used in the sub-levels for carrying the ore to the chutes, while in the Fayal cars are used.

When the first "sub" is sufficiently caved, the second sub is



STEAM SHOVEL AT WORK.

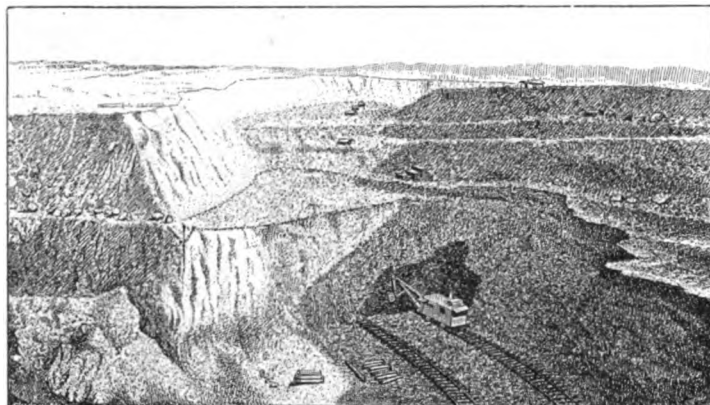
then blocked out and caved, this process being carried on down to the bottom or main level, from which the ore is taken out last of all. By this method a great deal of timber is used, but it is simply drift timber consisting of two legs and a cap, lagging being put in overhead and planking on the floor below. The timbering is not nearly so difficult or expensive as in the square-set method, since all the timber can be easily taken down the timber shaft or timber chutes, and from thence transferred along the drifts and put in place. It does not have to be pulled up through raises or hoisted into place, as is necessary in the square-set-room method; also the posts used do not have to be nearly so large. This method of sub-drifting and caving appears to be well suited to working these soft ore deposits in which patches of low-grade ore and rock occur. The chief advantage of this method compared to square-setting is that there is much less waste in the pillars from crushing and practically all the ore may be safely taken out, and at the same time low-grade ore and rock can be left with very little inconvenience. It is a safe and rapid manner of getting the ore but has the disadvantage of requiring an immense amount of timber.

In the Genoa mine a vertical shaft especially designed is used for handling the timber. The timber is cut on the surface at the timber-pile, loaded on trucks and wheeled onto the timber-cage at the top of the shaft. The weight of the timber in the trucks is sufficient when the brake is released to raise the balance weight from the bottom and cause the cage to descend. On reaching the level the timber trucks are pushed off the cage and along the tracks in the drifts to the nearest place to where the timber is required. Then the empty trucks are pushed back to the shaft and onto the cage and hoisted to the surface by means of the counter balance which is sufficient to raise the cage with the empty trucks. Injured men, empty cars, etc., may also be brought up in this cage more conveniently than in the main hoisting shaft.

At the Fayal mine timber slides are used for lowering the timber into the mine. They are made by putting raises to the surface on an incline of about 38 degrees. These raises are 5 ft. $\times$ 5 ft. in section and are fitted with slide-ways down which the timber slides. The slide-ways are flattened at the bottom to diminish the velocity of the sliding timber. The drifts in the main level and also some of the drifts in the sub levels have 12-foot caps and 8-foot legs making 10 ft. $\times$ 8 ft. in the clear. The slicing drifts have caps only 8 feet wide and generally legs of the same height.

The square-set method of mining was at one time quite extensively used in working these mines, but now has been largely replaced by the above described method of sub-drifting and

caving. But as it is still used to some extent perhaps a short description of this method may be desirable. In the Fayal mine a special system is used for removing the pillars between the rooms. The rooms are worked out by overhead stoping, and square set timbering put in three sets high, and three sets wide, leaving a pillar between the rooms of the same width and height. In order to remove the ore in these pillars a plan was introduced by the head mining captain which I believe has never been used



STEAM SHOVEL METHOD OF MINING.

elsewhere but has been found to work very successfully there. At the farthest end of the two rooms and next to the rock, the lower portion of the pillar between the rooms is first removed and the bottom set put in place, next the portion above is removed and the second and then the third set erected over the first set. This process is carried on from the back forwards a distance of three or four sets and when the weight on the timber between the pillar and the rock becomes so great as to threaten crushing it, then this timber is blasted down and the sand allowed to cave in, thus taking the strain off from the remaining part of the pillar, and allowing of its removal by the same process continued. In case the weight on the timber in the rooms should cause them to cave before the pillar was removed then the pillar would be taken out by top slicing as in the subdrifting and caving method. The ordinary method of mining by square set rooms is different to the special method used in the Fayal as described above. At some of the mines the rooms are caved by blasting in the roof and timbering while in others they are filled by running in the overlying drift through raises put up for this purpose, and it is only after the rooms have been caved or filled, that the pillars between are attacked and removed. Filling the rooms is a slow and expensive process, and if the rooms are caved, the pillars become broken and crushed and there is much loss of ore, as only a portion of the pillars can be removed with safety, the rest having to be left and wasted. Altogether it appears that this method is not a satisfactory one to use in these deposits, and it seems likely that it will soon be almost entirely abandoned.

A feature common to the Fayal, Genoa, and Auburn mines, is the use of special rooms underground for thawing dynamite. These rooms are warmed by steam heat, and contain lockers for the powder, one of which is assigned to each contract party. No candles are allowed in these rooms but a reflector is placed on the door outside on which the men place their candles thus obtaining sufficient light in the room without the danger of fire.

Many of the mines which were originally started either as simple open-pit, or purely underground are now worked by both these methods. This combination method of mining is locally termed the "milling" system. In the Auburn mine two levels have already been opened, the first having about 65 feet of ore above it, and the second level about 60 feet. The first level was laid out on the diagonal plan, the branch drifts having the main center drift at an angle of 45 degrees. The second level has been laid out on the ordinary rectangular plan, the branch drifts running at right angles to the main drift from the shaft. From each level the method of mining is the same, the ore above the first level being removed before the second level was used. From all the drifts raises were made to the top of the ore, which had previously been uncovered by stripping with steam shovels, which shovels after removing the surface deposit, are also employed in parts of the mine to load the ore directly into ore cars as in the simple open pit method. When the raises reach the top the ore is "milled" (is broken around and sent down) through them to the chutes below on the main level, from whence it is loaded into cars, trammed to the shaft and hoisted to the surface. The first raises are placed 40 feet apart, and when these are mined out a second series of raises are put up half way

between the first to tap the pyramid of ore left between the first. By making the raises a little larger at the bottom than at the top, it tends to prevent the ore sticking or becoming jammed in them. Holes are drilled around the sides of the craters by driving down with sledges pointed 1½-inch steel rods, varying in length from 5 to 13 feet. The time required to drive these rods varies with the hardness of the ground and the depth of the hole, and may be from ten minutes to an hour. Two to four strikers may be employed. To draw these rods which often stick very tight, clamps are fastened to the top, and railroad jacks are placed under the projecting arms of the clamp. When a rod has been drawn the first six or eight inches, it can generally be drawn the rest of the way without much trouble. These holes are first "chambered" with three or four sticks of 50 per cent. dynamite and then charged with three to ten 25 pound kegs of black powder. To prevent men from being carried into the raises by the sliding of the ore on the sides of the crater, ropes are kept within their reach. Through neglect of this precaution by the men, accidents of this nature have happened, but the men have been rescued from the craters by placing around them barrels, pieces of smoke-stack or any tube large enough to keep the ore from falling in upon and smothering them. With this protection the men have time to work themselves loose, and can be pulled out.

The Fayal, which shipped over a million tons in 1899, is the most interesting mine on the range. Here the "top-slicing and caving" method, and more than one form of the "square-set-room" method of underground mining are in use. Also "open-pit" work is done with the steam shovel and the "milling" combination method is used. In conclusion it may be said that although large shipments are being made annually from this range, yet there are vast areas of land which are known to contain good ore, which have not yet been touched, and it seems most probable that the Mesabi range will continue for years to come, to be the leading iron ore producer of the Lake Superior region.

Freight Rates From Buffalo to Upper Lake Ports in 1899.

The following rates are given by Mr. E. W. Parker in his report on the production of coal in 1899.

Month.	Chicago.	Milwaukee.	Duluth and Superior.	Gladstone.
April	\$0.30	\$0.30	\$0.30	\$0.30
May	\$0.30 to .50	\$0.30 to .50	.30	\$0.30 to .40
June	.50	.50	\$0.30 to .40	.40
July	.50 to .60	.50 to .60	.40	.40
August	.60 to .80	.60 to .80	.40 to .60	.40 to .60
September	.80 to 1.00	.80 to 1.00	.60	.60
October	.75 to 1.00	.75 to 1.00	.50 to .60	.60
November to close	.75 to 1.00	.75 to 1.00		

Box Car Loading.

Several months ago we published a description of a box car loader which was manufactured at Ottumwa, Ia., by the Ottumwa Box Car Loader Co. for the purpose of loading coal into box cars. At that time the industry was in an embryo state, and while the machine had been demonstrated to be more or less of a success, it had not come into use enough to entitle the manufacturers to say that they had fully demonstrated that it was what the coal operators of the country wanted. They now, however, report that they have sold and placed nearly fifty of these loaders in different parts of the United States and Canada, and their orders are constantly increasing.

The question of loading coal into box cars in proper condition for the market, and without delaying and decreasing the capacity of the mine, has been a serious problem with coal operators for years. Some companies have arranged a special track on which to load box cars, and have dumped only a portion of the output of the mine into box cars, thus giving the men ample time to keep the coal away, and thus avoid delaying the mine as would be done were all the coal dumped into the box cars. This however, has if anything added to the expense of loading for the reason that the men are not so crowded at their work, and consequently do not take care of as much coal as they would otherwise. At many of the mines the estimated expense is 4 cents per ton for handling coal after it has been dumped into box cars. The manufacturers of this Ottumwa loader claim to be able to do the loading for from ½ cent to 1 cent per ton. Such a saving as this is an important item, and especially if it is combined with the advantage of having the coal loaded in much better condition for the market because of more careful handling. There are always seasons of the year when it is difficult to obtain enough open cars, and if parties are prepared to do box car loading, it will often avoid having to shut down their mines.

LAKE SUPERIOR COPPER MINING.

Facts in Regard to the Enormous Production of the Region and the Large Returns in Dividends.

Written for MINES AND MINERALS, by Horace J. Stevens.

The year 1899 was marked by the largest dividends ever paid by Lake Superior copper mining corporations. The earnings for the present year will probably be nearly or quite as large as last year, but the dividend record will be smaller, for two reasons, one of which is the reduced dividend paid in June by the Calumet & Hecla, owing to the fire of the preceding month in that mine, the extent and damage of which was then undetermined. The second reason is that the dividends of the year 1899 were abnormally large, owing to the conflict between the calendar year and the fiscal year of the Calumet & Hecla. That mine has never paid more than \$8,000,000 in any of its fiscal years, which end on April 30, but for the calendar year 1899, the total dividend disbursements were \$10,000,000. This swelled the grand total of Lake Superior copper dividends for 1899 to the magnificent sum of \$12,318,000, or nearly double the amount paid in any preceding year. The wonderful growth of the Lake Superior copper properties in earning power is shown by the following table giving dividend payments for the past ten years:

Year.	Dividends.
1890	\$3,415,000
1891	3,540,000
1892	3,260,000
1893	3,520,000
1894	2,380,000
1895	3,280,000
1896	3,985,000
1897	5,431,000
1898	6,853,000
1899	12,318,000
Total	\$47,982,000

For the current year, dividends paid and declared to and including Oct. 1 are as follows:

Mine.	Dividends.
Atlantic	\$80,000
Calumet & Hecla	5,000,000
Osceola	279,000
Quincy	900,000
Tamarack	420,000
Wolverine	240,000
Total	\$6,919,000

In addition to the dividends listed in the foregoing table, the following amounts are likely to be disbursed as profits to shareholders by the mines named, before Dec. 31:

Mine.	Dividends.
Calumet & Hecla	\$2,000,000
Osceola	279,000
Tamarack	420,000
Total	\$2,699,000

This makes a probable total of \$9,618,000 in dividends for this year. There is a possibility that an even larger dividend may be declared by the Tamarack, and the Calumet & Hecla may add the million withheld in June, in which case the dividend disbursements of the year would considerably exceed ten millions.

With the payment of its last dividend, in August, the Quincy mine brought the grand total of dividends from Lake Superior copper mines above the hundred million dollar mark. The following table shows the dividend payments by decades, the first item covering the year 1849 only, when the Cliff mine paid the first profits earned by any Lake Superior copper mine, and the last item covering dividends paid or declared to and including Oct. 1, 1900:

Period.	Dividends.
Year 1849	60,000
Decade ending 1859	2,340,000
Decade ending 1869	3,770,000
Decade ending 1879	18,298,820
Decade ending 1889	23,762,500
Decade ending 1899	47,982,000
9 mos. to Oct. 1, 1900	6,919,000
Total	\$103,832,120

The mining districts of the world that have paid a total of more than one hundred million dollars in profits are very few in number. The grand total of one hundred millions achieved by Lake Superior copper mines places this district in advance of all other American mining fields in actual profits earned and paid.

The dividend payments of the districts, to and including Oct. 1, 1900, have been made by the following named mines:

Mine.	Total Dividends.
Atlantic	\$860,000
Cliff	2,518,620
Central	1,970,000
Copper Falls	100,000
Calumet & Hecla	70,850,000
Franklin	1,240,000
Kearsarge	160,000
Minnesota	1,820,000
National	\$20,000
Osceola	8,373,500
Pewabic	1,000,000
Phoenix	20,000
Quincy	12,320,000
Ridge	100,000
Tamarack	6,690,000
Wolverine	510,000
Total	\$103,832,120

An interesting feature of the past mining operations in this field is the ratio of dividends to the gross value of the copper production. Preceding the year 1849, when the first dividend was paid, but a few hundred tons of copper had been secured from Lake Superior mines, within modern times, though from the evidence of mining left by prehistoric races it is certain that many hundreds and perhaps many thousands of tons were secured in ages long past by the aboriginal residents of the North American continent. The total value of the Lake Superior copper product, by years, for the past ten years, is appended:

Year.	Value Product.
1890	\$15,819,960
1891	14,574,727
1892	12,431,624
1893	12,105,145
1894	10,852,122
1895	13,877,109
1896	15,758,935
1897	16,530,843
1898	17,829,871
1899	26,088,382
Total	\$155,878,718

During this same period the dividends amounted to \$47,982,000, or nearly one-third of the gross value of the copper. The estimated value of the copper product of Michigan for all years, from 1845, when the first product of twelve tons was secured, until the close of 1899 is \$389,584,204. The dividends in the same period were \$96,913,120, showing that of the gross value of the product for 55 years, 24.8%, or almost exactly one quarter, was returned to shareholders in dividends.

There is, however, a dark side to this roseate financial showing. Tens of millions have been sunk in various mining enterprises, for which little or no return has been secured. It is probable that more than half of the money so lost has been wasted, through incompetence or otherwise, leaving less than half of the money actually sunk without returns for investment in properties which apparently had reasonable chances of success under good management. Mines like the Calumet & Hecla are not lying around loose, for the benefit of those who seek, and even a good property requires millions for its development.

In addition to being one of the most profitable mining fields of the world, it may be stated without fear of contradiction that the Lake copper district is also one of the most expensive in which to open a mine. No property should start existence with less than a quarter of a million cash in the treasury, after acquiring title to the lands and paying all preliminary expenses. Half a million in the treasury is much to be preferred to a quarter of a million and an even ten hundred thousand dollars is still better. The Isle Royale Consolidated, now engaged in reopening a group of old mines in this city, begun corporate life less than four years ago with a cash surplus of one million dollars in the treasury, after acquiring title to the three mines in the consolidation, and in 1899 the Miners Copper company was absorbed, with its cash surplus of one million, giving the Isle Royale Consolidated the magnificent sum of \$2,000,000 for the development of its property.

It is probable that Calumet is now the largest mining camp in the United States. This honor has long been claimed by Butte, Montana, but the recent Federal census gives that town a population of only 31,000, instead of the 50,000 to 60,000 claimed for several years. Calumet, unfortunately, is not a city, but a collection of locations having village and township governments. It sprawls over three townships and is located in two counties. As there are upwards of 9,000 men employed in and about its mines, to say nothing of about 2,500 men engaged in various other occupations, there can scarcely be less than 40,000 people there. The number of mine employes is materially larger than in Butte, where about 7,000 men are employed in and around the mines.

It is probable that by the close of this year between \$5,000,000 and \$6,000,000 will have been invested in new stamp mills and

machinery within three years by the Lake Superior copper mines. The size and quantity of machinery coming into the district is marvelous and can be understood only from actual sight. It is only within the past few years that the Calumet & Hecla has been able to get its largest steel castings made in the United States, previous orders having been filled by Friederich Krupp, from his works at Essen and Magdeburg, Germany, he being the only manufacturer in the world then capable of turning out steel castings and forgings weighing fifty to seventy tons. American manufacturers are now equipped to care for this work, though not every town possesses establishments that can turn out such jobs.

The Calumet & Hecla is now using about 350 power drills in its mines. No other mine in the world has so many as 250 power drills at work.

Among the improvements in the district none are more noticeable than the many new stamp mills. No mill is being built of less capacity than 500 tons daily, and but one of that size. The mills not only cover vast areas themselves, but require an average frontage of one mile each, upon Lake Superior or some of its arms, to care for the enormous volume of sand carried out daily. The Osceola and Tamarack have each completed new mills within the past fifteen months, and the new mills of the Arcadian and Franklin were put in commission only last summer. The Calumet & Hecla is building a big new mill to have six steam stamps, which will care for the rock from the amygdaloid openings of the mine. The Quincy is building a large new mill, the operation of which will soon be reflected in increased production and enlarged profits. The Mohawk will build a mill next season, at the mouth of the Tobacco river, on Grand Traverse Bay, Lake Superior. The Centennial will probably build a new mill also next season, its present milling plant being too antiquated for economical production on a large scale. The steel superstructure of a new four-stamp mill for the Baltic will be begun within ten days, opposite the mill of the Atlantic, at the mouth of the Salmon Trout river, where the first steel gravity dam in the United States is now nearing completion. The Trimountain and Champion mines are both casting about for suitable millsites, the latter having a tract under option at the mouth of the Misery river. The Isle Royale is completing a mammoth new mill at the mouth of the Pilgrim river, Portage Lake. The Mass is building a one stamp mill at Ogima, on Keweenaw Bay. The Adventure will probably begin a mill next year and the management of the Michigan is seeking a suitable site, the mill test of 1,000 tons recently made at the Atlantic mill having proven satisfactory. The cost of the buildings and machinery of the least of the mills enumerated in the foregoing list will not fall below \$100,000 and the average will be nearly double that amount. Fifteen mills, built within the past two years, now building or planned for next year, have been enumerated in the foregoing list, and it is probable that their collective cost will range between two and a half and three millions of dollars.

In addition to the cost of building and equipping these mills, between two and three millions have been expended on new railroads, built to serve these mines. The Mineral Range railroad built a branch line to accommodate the Franklin, Franklin Junior and Arcadian mines. The Mohawk is building seven miles of new line to connect with a seven-mile logging road running to its millsite. The Arnold built a railroad in Keweenaw county to connect its mine and mill. The Osceola and Tamarack mines have completed a survey for a projected line to connect their mines at Calumet with their mills on Torch Lake. The Mineral Range is completing a forty mile extension, built to connect the mine and mill of the Mass company, and the Copper Range Railroad company has built and equipped a forty mile railroad line running from Houghton to Mass City, Ontonagon county, at a cost of perhaps a million and a quarter, and will build a fifteen mile extension to Calumet next year.

In the way of new machinery plants, costing from \$10,000 to \$1,000,000 each, at least a full column would be required for a mere enumeration. Every Lake Superior copper mine which is not moribund has been investing in machinery, and the machinery so bought has usually been of the most massive and costly nature. The hoisting plants range from a few hundred horsepower to 8,000 horsepower each. The fifty thousand horsepower now being generated at Niagara Falls would all be required to run the Calumet & Hecla mine. At a single one of its seventeen great shafts there is an 8,000 horsepower hoist, steam for which is supplied by 10 boilers of 1,000 horsepower each.

The Lake Superior copper mines are spending money like water, but the cash is going into betterments which will enable the mines to produce copper more abundantly and more cheaply than ever before, when an era of low prices again dawns.

The New Electric Sinking Pump.

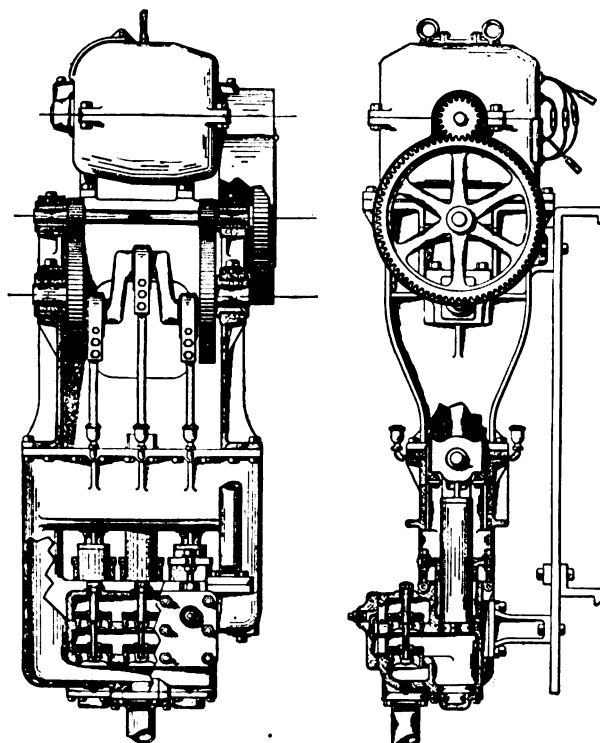
A pump for use in shaft sinking operations occupies a unique place amongst mining machinery. Such pumps are called upon to perform work under conditions entirely different from every other class of pumps and of most other machinery. While such a pump is expected to answer most of the requirements of any other good machine it must have peculiar characteristics in order that it may give satisfaction under the very trying conditions

under which such pumps must nearly always be used. While steam economy and smoothness in operation are very desirable features the requirements of a first class sinking pump are the following: *First*.—Absolute reliability of operation. *Second*.—Ability to pump both air and water. *Third*.—Small space, accessibility of vital parts, lightness, but designed to contain sufficient material to produce strength.

The illustration herewith presented shows the Jeaneville triplex electric sinker pump built with water proof motor, as manufactured by the Jeaneville Iron Works Co., Jeaneville, Pa., and Denver, Colo.

This sinking pump is the direct result of the great demand there is at the present time for the application of electricity to all kinds of mining operations. The makers claim for it the following characteristics and advantages: *First*.—It can be operated by an electric current, direct from a water power situated miles from the point of application. *Second*.—It produces no heating effect in the shaft, and the steam pipe is entirely eliminated. *Third*.—It is a most economical and efficient pump in power consumed. *Fourth*.—When the pump is stopped there is no waste of current, and when in use, current is consumed in the exact proportion to the work performed.

The construction of the pump as shown by the illustration is as follows. There are three single acting plungers operating from a common crank shaft with the crank pins placed at 120 degrees apart, the resultant action of these three plungers being the production of a continuous and constant stream to the column pipe and the reduction to a minimum of the shock and jar upon this pipe. The water cylinders are cast in one piece and are connected to the guides by hollow castings which form a vacuum chamber on one side and an air chamber on the other. The valves are of the well known type used in the Jeaneville steam sinker pumps and are easily accessible through hand holes at the face of the valve chamber. All of the gearing is machine cut and designed with sufficient strength to give a liberal factor of safety. All parts are completely accessible for oiling and inspection. The pump frame is designed to receive any make of motor which is adapted to this kind of work and which may be either direct or three-phase current. These pumps are built of different sizes and are guaranteed for one year against all breakages and repairs due to poor material, workmanship or design. Full particulars can be obtained by applying directly to the Jeaneville Iron Works.



Triplex Single-acting Electric Power Sinking Pump.
Jeaneville Iron Works Co., Jeaneville, Pa., U.S.A.

MINING PRACTICE

In Butte, Montana, Copper Mines. Methods Employed in the Various Operations.

Pumping Plant, Hoisting, Method of Repairing Ropes, Signaling, Boiler Plant, Blacksmithing and Sharpening Drill, Surface Works, Mine Accounts and Costs.

Written for MINES AND MINERALS by R. B. Brinsmade, B. S., E. M.

(Concluded from October.)

Pumping.—The Anaconda Company has its drainage so arranged that the pumps of the St. Lawrence shaft drain the Anaconda group and those of the High Ore shaft drain the Syndicate group. The other companies with groups of mines pursue a similar arrangement. The pumping installation of the High Ore and St. Lawrence shafts, which represents the latest practice, is as follows: the pumping is done by relays of approximately 500 feet each, and the station pumps are in duplicate, each having its own water column, and one pump being as a rule held in reserve. There were 3 new pumps put in in each shaft at the time of the adoption of this system in 1899. Each has a capacity of 500 gallons a minute at 600 ft. head, speed 50 revolutions per min., and a water end of $5\frac{1}{2}$ in. $\times$ 30 in. and an air end of 17 in. and 28 in. $\times$ 30 in. They are compound-duplex-plunger pattern, the water ends are built entirely of a special bronze, and there are no parts of the pump below the basal plate of its cylinders. They were made by the Dickson Mfg Co., of Scranton, Pa. The old pumps that complete the relays are of the same capacity but of Knowles make. The power furnished the pumps is compressed air delivered at 80 lbs. to 90 lbs. pressure, the pumps being designed for a pressure of 60 to 80 lb. at the throttle, the air is twice reheated by steam; first, before entering the high pressure cylinder and secondly in the receiver between the high and low pressure cylinders.

The first water columns used to resist corrosion were iron pipes lined with wooden staves; then the iron pipes were lined with $\frac{1}{8}$ in. sheet lead and the staves put inside this; the final solution of the problem was reached by using an iron pipe lined with $\frac{1}{8}$ in. sheet lead, which resists both pressure and corrosion. Fig. 30 shows a detail of this pipe, which has rendered unnecessary the wood lining, and has thereby decreased the friction of pumping by increasing the available cross section for the water, and has saved the expensive repairs of the stave lining. The joint is made by a special rubber gasket fitting into a groove, in the flange, Fig. 30, and the pipe is peened onto the cast iron flanges at each end.

Expansion joints placed every 200 ft. to 300 ft. along the columns permit of the easy replacement of worn lengths. At each pump station there is either a large brick cement-lined sump from which the pump draws, or a wood or natural rock tank above the pump. The suction strainers are either perforated bronze castings or perforated hollow cottonwood cylinders.

At the Anaconda group the mine water has leached the zone of the mine oxidized by the great fire, and it contains from 9 lbs. to 13 lbs. of copper per ton of water. This water is passed underground through sumps containing scrap iron, which reduces the copper contents down to from 2 to 4 lbs. to the ton before it reaches the pump sump. The residual copper is precipitated by large scrap iron vats on the surface.

At the Parrot mine the water is neutralized by lime placed in the tank which feeds to the pump, a stirrer driven by the pump rod keeping the lime agitated. The lime by reducing the acidity retards the precipitation of the copper on the surface, but it is undoubtedly the best method of saving the pumping apparatus at those mines where sulphuric acid and not copper is the corroding element. The water columns are kept clean by draining them occasionally as the ferruginous sediment does not harden. At the Parrot mine the pump at the 1,000 ft. level pumps direct to the

surface through a bronze column 5 in. internal and 6 in. external diameter and in 12 ft. lengths. The bronze lengths are peened on cast iron male and female flanges, and the flange joints are sheet rubber-gaskets. The pump itself is run by steam at 100 lbs. pressure and is duplex-compound-condensing, with jet condensers.

All the large pumping installations at the time of the writer's visits, with the exception of the above mentioned Anaconda plant, were run by steam taken down the shaft, the exhaust being condensed in the pump sump. Where the ventilation is deficient this large steam pipe has the advantage of making the shaft a strong upcast, and it is probably more efficient mechanically than the reheated air system for depths less than 1,000 feet. The condensation of the steam has the disadvantage of heating the sump water and thus causing a faster dissolution of the pumping apparatus.

Steel bailing tanks operated by the ore hoisting engine are used occasionally at all the large properties and at the Rarus mine they constituted the chief method of unwatering. This method keeps the shaft very wet. One pumpman on a 12 hour shift tends one pump station and often 2 or 3 stations in one shaft; for repairs or for working on the column pipe he has the help of the mine machinists and pipemen. Fig. 31 shows an efficient column-lifting device installed on the 600 ft. level of the Silver Bow No. 1 Mine. This apparatus enables the 400 feet of column pipe below the 600 ft. level where most of the wear is to be easily manipulated to replace a worn length.

The construction of this apparatus is as follows: There are two hydraulic cylinders *A* in each of which is a piston. A small steam pump, not shown in this sketch, forces black oil into the pistons *A* and these pistons then lift the eye-beams *B* which are supported on a pivot joint. The beams *B* enclose the column pipe *E* and by means of the pendant arms *G* and the cross piece *D* the column pipe is lifted when the beam arm *B* is raised.

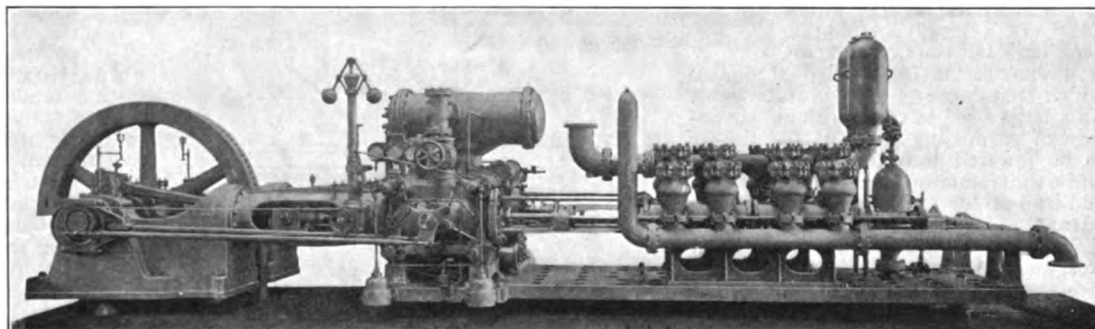


FIG. 29.—DICKSON MFG. CO. COMPOUND DUPLEX PUMP, ANACONDA MINES.

At *F* is a square threaded screw that works in a nut attached to *B* and this enables *B* to be held at any required height when the column pipe is attached to it.

Hoisting.—Though the hoisting engines in the Butte district are of numerous makes, for the deep shafts they are practically all of the same type, i. e., first motion, with jaw or friction clutch and with flat-rope reel, the steam cylinders being simple. At the Blue Jay for an inclined shaft a round rope drum is used, as also at some of the shallower mines like the Berkeley and Silver Bow No. 3. On the large engines the valve gear is as a rule of the Corliss pattern with a Stevenson link motion for reversal. The throttle and relief valves, and the disc brakes are thrown by hand levers, but the reel brakes and the clutch are operated by steam power. The maximum rope speed is 4,000 ft. per minute, though at the Bell shaft a speed of 6,000 ft. per minute has been noted.

The brake blocks are made of cottonwood and the flat shape has been found more efficient than the wedge. The head frame sheaves for the flat ropes are 7 ft. to 10 ft. diam., and usually are made of cast iron with no liners in their grooves.

The ore in hoisting is usually counterbalanced as the station tender empties one underground station at a time of its cars. The load per trip varies at the Anaconda mine, which has one of the largest plants; the maximum load is, without counting the $\frac{1}{2}$ in. $\times$ 7 $\frac{1}{2}$ in. flat rope,

Double deck cage =	4,315 lbs.	
2 cars =	1,600	
2 cars of ore =	3,600	Total, 9,515 lbs.
5-ton skip =	5,550	
Ore in skip =	10,000	Total, 15,550

Grand total, 25,065 lbs.

This is handled by a 48 in. $\times$ 72 in. simple duplex hoist built by the Union Iron Works, San Francisco, Cal.

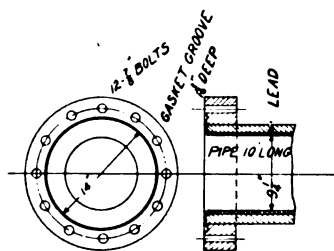


FIG. 30.

At the Never Sweat mine with 2-deck cages and with an 8-ton skip above them on one rope (at the Anaconda the skip is hung underneath the double deck cage), the cage and its load weigh the same, but

The 8-ton skip weighs 5,950 lbs.
8-ton skip load of ore weighs 16,000

Total, 21,950
Total cage, 9,515

Grand total, 31,465

This is without the $\frac{1}{2}$ in. $\times$ 8 in. flat rope. This load is handled by a 26 in. and 46 in. $\times$ 72 in. vertical duplex compound Corliss engine built by the Union Iron Works. The compounding has been a source of vexation owing to the consequent complication of parts and the difficulty of equalizing the load between the high and low pressure cylinders.

Most of the smaller mines use only a single or double deck cage, but the Colusa shaft is unique in having a cage of double width that carries 4 cars on its 2 decks. This large size has the additional advantage of permitting much of the timber to be lowered into the shaft flatwise, while the tramming horses can be lowered and raised for each shift, an unusual advantage for such animals.

The cages themselves are of structural steel and Norway iron throughout. Some two years ago an enclosed cage law was passed by the state legislature to protect miners, who if affected by bad air often fell off the open cages. The first attempt to obey the law was a sheet steel box, used at the Parrott mine, and shoved onto the cage proper on wheels; this was heavy and reduced the man-carrying capacity of the cage. The best device is a steel lattice work fixed to the cage, the ends of which can be folded up snug when not in use. This lattice is of great assistance in holding timbers on the cage so that which at first was thought a hardship has proved a blessing in disguise.

Not more than half the shift is usually consumed in hoisting rock; the balance being occupied in handling timbers and men. Though only adopted in Butte two years ago by the Anaconda Co., the skip presents great economy over the cage for rock hoisting. A skip saves weight and therefore power and time in hoisting, requires fewer station tenders, and most of all it saves cars; for by the employment of a shaft ore bin on each level cars are constantly in use and car men need waste no time waiting for empties.

The older mines in Butte have small shaft stations that retard the economical handling of cars for large ore production.

Care of Rope.—No doubt one reason for the preference for flat rope in Butte is the ease of inspection and repair. The safety dogs on the cages are tested once a week in the following manner: A 10 in. $\times$ 10 in. timber is put across the gallows frame at the base and the cage hung from it by manila ropes, the hoisting rope having been previously slackened, the manila ropes are then cut causing cage to fall, when dogs if in good condition will catch the cage.

Ropes constantly in use are tarred once a week, the cage being hoisted to the shaft collar and slowly lowered, the hot tar being applied meantime in a thin layer with a brush by one man on each side of the rope. The "tar" is a mixture of one barrel of pine tar to 20 gallons of beef tallow. While tarring, the ropemen inspect carefully the rope for flaws.

Every 8 months at the large producers, up to an interval of 2 years for the smaller mines, the flat rope is removed from the shaft and made over. There is always 1 and often 2 ropes in reserve for a shaft. An excess of 200 feet of rope above the shaft

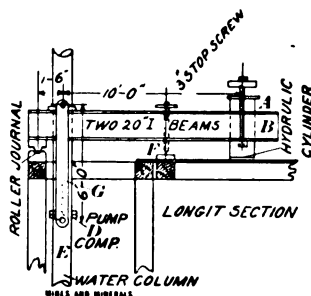


FIG. 31.



FIG. 32.

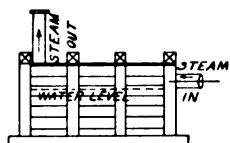


FIG. 33.

depth is placed on the reel, so that the reel rope is still good while the part above the cage may be worn worthless.

The operation of making over a flat rope, is as follows: It is first unwound from the engine reel onto a wood reel A, Fig. 32, turned by power. The reel A is then removed to the rope house, a low building 80 ft. to 100 ft. long, and placed at one end on a frame, Fig. 32, arranged with power gears for winding in either direction. There is a similar empty reel B, on frame at the other end of the rope house. The following operations take place:

I. The rope is wound from A onto B and passed in the operation through a tank of raw naphtha to clean it.

II. The rope is wound back from B onto A, all the binding "thread" of the strands being cut while doing so.

III. The rope is wound back onto B, the binding threads being removed from the rope, the defective strands cut out and new strands spliced into their place.

IV. The rope is wound back on A and strands sewed together again by new binding thread as in making new rope.

V. The finished rope is then rewound onto B, passing in the process through a tank of hot tar.

The new flat rope is also made at the rope house by sewing together enough ropes to make the required width, $\frac{1}{2}$ in. or $\frac{3}{4}$ in. ropes of 4 coreless strands of 7 wires each being employed. The "thread" is 12 strands of No. 6 Norway iron, twisted, and used in 30 ft. lengths. A ropeman and helper can sew 80 ft. of $\frac{1}{2}$ in. $\times$ 5 in. rope in 10 hours; and a splice of a $\frac{1}{2}$ in. rope is effected in 15 minutes. The round ropes are also renovated when necessary, badly worn lengths being cut out, and new pieces spliced in their place, if the rope is worth it, cleaning by naphtha and subsequent tarring being performed as for flat ropes.

Hoisting Signals.—The engine telltale is commonly a large disc with a pointer turned by a bevel gear from the reel shaft; in addition the rope is painted white to indicate the collar of the shaft and other important points. There are 2 independent

signalling systems, the call for the station tender (or cage rider), and the system employed by the station tender to notify the hoisting engineer. The first system is either an electric bell, or an electric switch at each level that flashes simultaneously every light in the mine (the shaft conductors, to allow this, being three wires),* and the latter system is a manila bell rope in the shaft.

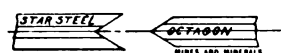


FIG. 35.

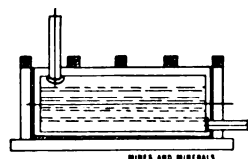


FIG. 34.

The Montana State Code of Signals is as follows:

2 pause 1 denotes	100' level	} Signals for electric system.
2 pause 2 denotes	200' level	
2 pause 3 denotes	300' level	
2 pause 4 denotes	400' level	
2 pause 5 denotes	500' level	
3 pause 1 denotes	600' level	
3 pause 2 denotes	700' level	
3 pause 3 denotes	800' level	
3 pause 4 denotes	900' level	
3 pause 5 denotes	1,000' level	
4 pause 1 denotes	1,100' level	
2 pause 1 pause 2,	station tender does not understand.	

1 stop if in motion	} Signals by bell rope.
1 hoist rock	
2 lower	
3 hoist men	
4 get ready to hoist men away from blast	
5 steam on	
6 steam off	
7 air on	
8 air off	
9 accident, then ring station signals	
3-2-2 send down drills	
3-2-3 send down picks	

After a man has rung station signal on the electric system, the station tender answers one bell, then if a man wishes to go up he rings once, if down twice, if station is only full of rock, the man does not reply.

Air Compressors.—All the large mines are provided with compressed air. The Anaconda and the Boston & Montana companies have central plants from which air is piped on the surface for thousands of feet to the various shafts. The Nordberg, Riedler, Rand, Ingersoll-Sergeant or Norwalk makes are used,

*See MINES AND MINERALS, Vol. XIX, page 486 for description of the flash-signaling system.

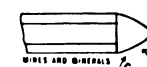
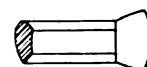


FIG. 36.

they are practically the same type, viz., cross-compound steam end with Corliass valves, and cross-compound air cylinders with inter-cooler. One of the largest is the Ingersoll-Sergeant compressor at the High Ore mine, the steam end of which is 30 in. and 56 in. $\times$ 60 in. stroke and the air end 30 $\frac{1}{2}$ in. and 60 in. $\times$ 60 in. stroke, non-condensing and running about 60 revolutions per minute.

The outlet valves are usually positive and the inlets of the poppet type, the fresh air being taken in from the outside of the building through a galvanized iron pipe. The air after compression is cooled at the Anaconda mines by passing it through a series of several old boilers placed outdoors, the compressed air circulating through the shell, while the atmosphere traverses the boiler tubes. Underground the air is reheated for the pumps and large hoists by reheaters in which the air circulates around a steam coil. Where steam is not available, I have seen reheaters consisting of nests of circulating pipes for the compressed air heated by oil stoves underneath. Each of the Anaconda Co.'s mines is provided with an automatic air pressure register, recording a curve that indicates the pressure for any minute of the day.

The air columns in the mine shafts are common sleeved and flanged, welded iron pipes with a branch at each working level. In the levels the air drills are connected to the air main by lengths of wire-wound rubber hose 30 ft. long.

Boiler Plants.—Though return tubular, locomotive and patent water tube boilers are in operation, the most improved practice uses the Scotch marine type, which is very efficient for the continuous steaming that is necessary in Butte mining practice.

A large battery of these marine boilers in 250 H. P. units is installed at the Anaconda, and another at the Green Mountain mine, each plant having a large self-sustaining steel stack. Fan draft is as yet unknown among Butte boiler plants and under present conditions would be of doubtful advantage.

The boiler feed water is from the city mains and no water purifier is necessary. A vegetable compound fed at intervals so loosens the scale that the boiler cleaner can easily scrape it out on his monthly visit. The boiler tubes are blown out every 24 hours by a steam hose, and the stack is also blown out by steam on those boilers with individual stacks. The boilers burning Wyoming slack, which is low in ash, have bar grates with slits for slack burning; the Belt and other coals rich in ash require the employment of shaking "finger" grates.

Feed Water Heaters.—The old type, Fig. 33, consisting of a wooden covered tank into which the exhaust steam entered above the surface of the water that nearly filled the tank and passed out through a wooden flue were leaky and inefficient. Mr. Ames, of the Anaconda Co., used an old boiler, Fig. 34, in a wooden tank. The exhaust steam entered through one end of the boiler shell and out through a flue at the top, while the feed water in the tank circulated through the boiler tubes, thus making a very good apparatus.

Steam Purifiers.—At the Silver Bow No. 1 mine, where the boiler plant feeds a large pump at the 1,000 ft. level and also the hoist on the surface, the condensed water all goes down the column to the pump station, where it is separated by a separator before the steam enters the pump. At the High Ore mine the steam is nearly all used on the surface, so that it is purified by a centrifugal separator before leaving the boiler house.

Repairs.—The Anaconda Co. has its blacksmith and machine shops at the Anaconda mine, with smaller repair shops at other mines. More complicated repairs are effected at the foundry in Anaconda, where small hoists and pumps, boilers and nearly everything else but the larger machinery is constructed. The Boston & Montana Co. has a large repair shop at its Leonard

mine, while a number of local iron works do necessary repairs for the other companies. Nothing in the machine shop practice is especially worthy of note.

Blacksmith Shop.—The wasteful practice of blowing the forges from a branch from the compressed air main, has been abandoned for the fan blast at most of the mines. A pipe cutter, drill press and sheet shear with the addition sometimes of a steam hammer, (made by the substitution of a hammer for a bit in a rock drill set vertically) are the tools in most of the small shops.

Machine Bits.—The X drill bits are made as follows: Fig. 35. A bit of Star steel is cut 18 in. long and then split at one end, the octagon steel shank of the required length is then cut with one end wedge shaped and welded to the Star bit. The table shows the sizes of machine bits.

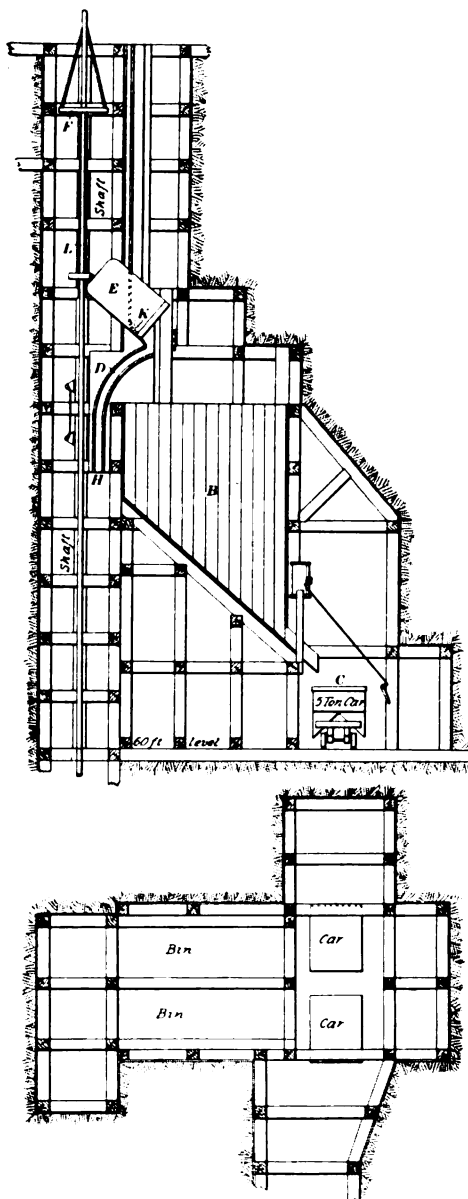


FIG. 37.

Length of Drill, Feet.	Diam. Star Steel Shank, Inches.	Width Cutting Edge, Inches.
2 to 4	1 $\frac{1}{2}$	2 $\frac{3}{4}$ to 2 $\frac{1}{2}$
4 to 6 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{4}$ to 2
6 $\frac{1}{2}$ to 9	1 $\frac{1}{2}$	2 to 1 $\frac{1}{4}$

The sharpening is done by hand, as so far no machine has proved efficient for the purpose. The cutting edge of the bits is made at an angle of about 60 deg. and the wedge sides are rounded convex. The tempering for machine and hand bits is effected by reheating the bits after sharpening, to a visible red and then plunging them into water, giving a white temper untouched by the file. From each sharpening the bits lose $\frac{1}{4}$ in. to $\frac{1}{2}$ in. and even 1 in. if the edge has been broken. The average amount drilled in rock before dulling is 3 ft. A tool sharpener and helper can sharpen 200 machine bits in a 10 hour shift.

Hand Bits are sharpened to a bull point, Fig. 36, and the $\frac{7}{8}$ in. octagon steel has a cutting edge as in table below.

Length of Drill, Inches.	Width Cutting Edge, Inches.
16 and 22	1 $\frac{1}{2}$
28 and 34	1 $\frac{1}{2}$
40 and 46	1 $\frac{1}{2}$
above 46	1

In sharpening, the bit is hit in direction F and not G, Fig. 36, to produce a durable point. The loss for a sharpening is $\frac{1}{4}$ in. to $\frac{1}{2}$ in., if the edge is not broken.

Picks.—The picks are tempered by heating to a yellow and drawing out the point, then cooled in water to a blue by plunging with a quick removal. Each miner is allowed a sharp pick every other shift.

Carpenter Shop.—The shop at the St. Lawrence mine can be taken as an example. It is of structural steel and contains a rip saw for cutting wedges and ripping plank, a crosscut saw on a swing arm to cut poles and the square timbers to proper lengths for framing, and a framing machine for the square sets, made by the Anaconda Co.'s foundry, which by setting can cut at one operation the regular set tenons at one end of a timber. At

W. A. Clark's mines there is a framer built by the Denver Engineering Works that can frame both ends of a timber simultaneously. Special tenons and mortises have to be cut by hand tools.

Surface Works.—The old style was well illustrated by the Parrot mine as it was in 1898. The wood gallows frame was enclosed by a large wood structure containing divisions for the carpenter shop, the hoisting engine, the compressor, the boiler plant and the change room, as well as the ore shipping bins. This arrangement was with the object of having everything convenient to the collar of the shaft, it also sheltered the men in handling ore and timber and in going from the shaft collar to the change rooms, considerable advantages in the stormy northern climate of this district. The new practice is exemplified by the

St. Lawrence mine where the steel head frame is bare, and there are separate steel buildings for the hoisting engine, carpenter shop, etc. This new scheme permits of the freer movement of material and is practically fireproof. The head frames themselves, both of steel and wood, consist of 2 upright posts only, backed by 2 back braces, with ample lateral bracing for stiffness between the posts, and a framework to hold the shaft guides, extending up to the sheaves. This construction with 2 upright posts is the cheapest and strongest for Butte, as none of the frames have rock crushers connected with them, the crushing being done at the concentrators. Several of the wooden frames are 80 ft. from the base to the center of the sheaves, the easily obtainable Oregon fir making this huge construction easy. The largest steel frames are those at the High Ore and Diamond shafts, built by the Gillette-Herzog Co., of Minneapolis, Minn., they are 100 ft. to the center of the sheaves.

All the large mines are provided with switches to their ore bins and boiler houses by either the Great Northern or the Northern Pacific systems, so that the whole district is a vast network of railroad tracks.

Change Rooms are a very important mine adjunct for the health of the men, where in winter there is often a difference of 80 degrees Fahrenheit between underground and surface temperatures. They are provided with steam pipes for drying clothes, sinks for washing, and the Leonard mine has even separate lockers for each man's clothes.

Ore Bins.—Where cars are used they are run direct from the cage to the shipping bins and dumped. The skips at the High Ore mine dump direct into the shipping bin, while at the St. Lawrence mine, they dump into a small wooden bin, whence the ore is fed into a 5-ton car and pulled by a mule to the shipping bin, 100 yds. distant. At the Anaconda mine the skips dump into a bin on the 100 ft. level, whence a mule drags the 5-ton transfer cars above the Never Sweat mine shipping bins through an underground tunnel. Fig. 37 shows the arrangement in the Anaconda shaft. The shipping bins themselves present various types of timber construction, Montana fir or pine. The favorite gate is the one raised and lowered in a vertical groove by rack and pinion. The bins have often steel linings of sheet steel or old rails.

In Fig. 37 *F* is the lower deck of the double-deck cage. The skip *E*, which holds 5 tons of ore and is hung from *F*, is self dumping. During hoisting the skip is held vertically by a hook attached to the frame *L*; this hook is struck upon reaching the trip *H* and the roller *K* on the side of this skip then runs out on the track *D* and dumps into the bin *B*. This track *D* is made up of a bent angle-iron bolted to steel plates and fastened to the sides of the hoisting compartment. The parts *H*, *D* and *K* are duplicated on the opposite side of the skip *E*. The bin *B* discharges into the 5-ton car *C* through a vertical sliding ore gate which is worked by a compressed air cylinder as shown. The car *C* is drawn through a tunnel about 1,000 feet by a small mule and dumped above the railway shipping bins. Timber and men are hoisted to the surface on the cages and the ore can be also hoisted to the surface on the cages in cars if it is desired to increase the capacity.

Supplies.—The Anaconda Co. has a number of subsidiary departments to furnish supplies. A large warehouse at the Anaconda mine furnishes vast quantities of mine supplies, kept constantly on hand, in the charge of a special clerical force. The hardware department that has a retail store on Main St., also supplies the mines. The lumber department with yards in South Butte is supplied by its own mills located in various parts of Montana. The ore is shipped on the company's own railroad, the Butte, Anaconda & Pacific, to the smelter in Anaconda, in which town is also located the company's foundry department already mentioned. The coal mines at Belt, Montana, and at Diamondville, Wyoming, supply the various mines with coal.

The Boston & Montana has nearly as complete an equipment as the Anaconda, but the smaller companies depend chiefly on the merchants for supplies.

Mine Accounts.—At each large mine there is a timekeeper, and at the mines of the Butte & Boston the system is as follows: The day shift men are checked off by the timekeeper going on shift at 7 A. M. and coming off shift at 5:30 P. M., the night shift men going on at 6 or 7 P. M. This record is kept in a time book and each month a time sheet is made out from it and sent to the main office of the company down town. The labor time is also daily divided by this timekeeper into ore breaking, tramming, timbering, hoisting, pumping, boiler room, repairs and alterations, prospecting, miscellaneous, on a special sheet, and sent to the main office for computation, the summation of these sheets forms a check on the monthly time report. He also orders and receives the necessary supplies and records in which account they were used, and from his supply book makes out monthly a separate sheet for each account which he sends to the main office, and by these the supply expense is not only quickly apportioned, but a check

is obtained on the invoices of supplies that have been received. The timekeeper also sends in a daily report of the ore and waste hoisted and the ore shipped, with the locality whence the rock came. All the general accounts and ledgers are of course kept in the main office in the Lewisohn Building down town.

Mine Numbers.—To facilitate these reports of the timekeeper, each working in the mine is numbered by a wooden sign hung up in it. The system is as follows: All the working numbers are for any level between the corresponding hundreds for that level's number, thus, C No. 511 would mean chute No. 11 on the 5th level, all the numbers on the 5th level being between 500 and 600. Each new drift or stope being given the number between 500 and 600 next following the last one in use. At the Pennsylvania mine the 100 numbers of a level are separated into two parts, one to represent the west and the other the east side of the mine, and this as a further amplification would probably be followed in all the mines if they were to be renumbered.

Mine Labor.—At the Parrot mine during the writer's engagement in 1898 an average production of 400 tons of shipping ore was maintained and the list of men per 24 hours and their rate of wages and duties were as follows:

1 mine superintendent (part of his time only) @	\$10.00	2 compressor engineers	4.00
1 timekeeper (part of his time only) @	3.50	2 firemen	3.00
1 mine foreman	6.00	2 wood passers	3.00
1 surveyor and helper	5.00	1 boiler cleaner (one-third of his time only)	3.00
2 shift bosses	5.00	1 boss machinist	5.00
2 pumpmen	4.00	1 pipeman	4.00
3 station tenders	3.50	1 ropeman and helper	4.00
1 blacksmith and helper	4.50	1 head carpenter	5.00
2 tool sharpeners and 2 helpers	3.00	2 carpenters	4.50
1 teamster	3.00	1 carpenter's laborer	3.50
4 top carmen	3.00	1 powder and tool man	3.50
3 hoisting engineers	4.00	6 timbermen, at	3.50
		170 miners, carmen, and shovel-	
		ers	3.50
		1 night watchman	3.00

As Butte is a strong union town the men have uniform hours of work, viz., 10 hours day and 9 hours night shift with an hour less per shift on Saturday, 7 days per week being worked. The men on 8 hour shifts were the hoisting engineers and station tenders, and those working 12 hours were the pumpmen, compressor engineers, and firemen. The carpenters worked 9 hours.

The high wages attract to Butte the best artisans and laborers in their respective spheres in the country, and as there is always a surplus the companies have usually no difficulty in finding good men. The unions place no restriction on the hiring and discharging of men and the new comers in the camp usually work for some time before joining the union. The only points upheld are the rate of wages and the number of hours per shift worked, and for many years there has been little friction between the unions and the operating companies.

Sunday work is pursued at the mines by all the companies, except those of the Bigelow syndicate. It has been found by the latter that, aside from any religious or social reasons for a weekly rest day, it is more economical for the companies.

Hospital.—A dollar a month is deducted from the wages of each employe for the hospital fund. The sums thus obtained are paid by the mining company to one of the private hospitals, of which there are several owned by physicians or by Roman Catholic Sisters, and each man receives from the selected hospital free surgery and board when disabled.

The Bigelow Companies have also a system of accident insurance by which each employe by paying a certain per cent. of his monthly pay receives during disability half of his accustomed wage.

Working Cost.—The cost is really the most important part of the mining operations from a business standpoint and is usually the most difficult thing for outsiders to obtain, while company officers are seldom free to disclose such figures.

The following figures of working cost for the Anaconda Co. appeared in the "Rossland Miner," Oct. 15, 1899:

Production of ore, 1,459,249; cost per ton, \$3.94; total, \$5,745,784.29.
 Tons concentrated, 1,459,249; cost per ton 77 cents; total, \$1,124,508.96.
 Concentrates smelted, 500,000 tons; cost per ton, \$6.40; total, \$3,200,875.
 Copper converted, 62,358 tons; cost per ton, \$17; total, \$1,073,988.55.
 Product refined at Anaconda, 30,153 tons; cost per ton, \$20; total, \$603,123.77.
 Product refined at Seaboard, 32,105 tons; cost per ton, \$30; total, \$963,891; grand total, \$12,964,614.

These figures are all rather high compared with the table of the Boston & Montana costs following. The reduction works are especially inefficient, all the costs of reduction, except the refining at Anaconda, being excessive, and these costs are due to inefficient machinery and badly arranged buildings for economical handling of material. These defects will be remedied in the vast new reduction works to be soon erected in Anaconda, as will also the large loss of copper, especially in concentrating, that takes place at the works now in operation.

The figures below were given by Mr. Maginnis of the Montana Ore Purchasing Co., as working costs of the Boston & Montana properties in 1898.

Cost of mining (estimated) per ton.....	\$2.00
Freight to Great Falls from Butte	.75
Concentration from 2½ to 1, per ton ore.....	.40
Calcination (reduction of weight 15%) per ton concentrates.....	.75
Smelting per ton of concentrates.....	2.55
Smelting per ton of ore.....	1.02
Smelting per ton of matte.....	3.00
Converting per pound of matte.....	.005
Electrolytic refining, per pound of blister copper.....	.01
Freight to New York, average per 100 lb. of copper.....	.70
Insurance, average per 100 lb. of copper.....	.05
Selling commission, Lewisohn Bros., 2½%.....	
Total cost of producing 1 pound copper, in New York.....	.0545
The loss allowed in concentration is set at 20%.....	
The loss allowed in smelting is set at 10%.....	
<i>First-Class Ores.</i>	
Smelting after calcination per ton of ore.....	\$2.55
Total cost per pound up to process of converting.....	.0134
Total cost per pound for treatment of 25% ore.....	.0384

The figures of *mining* cost, with which this article has alone to do, given for the B. & M. Co., are probably the minimum to be achieved under present prices of labor and supplies. As the mines grow deeper this cost will show a gradual increase, which, however, can be rendered almost imperceptible by the improved hoisting and pumping devices that have been lately introduced to provide for these items of increased cost from deep mining.

It is an interesting fact for the sociologist that the mining and smelting costs in Butte are actually less per pound of copper produced than in nearly any other district in the world, in spite of the highest average rate of wages paid at any copper camp. This is not only due to the high tenor of the ores, but largely also to the fact long ago noted by economists, that with a high rate of wages and a consequent influx of the most intelligent workmen, there is every incentive to equip a productive enterprise with the latest devices in labor-saving machinery; so that by the aid of this machinery, which is scarce in low priced labor districts as a rule, the labor cost per pound of product is much less than in those places using low-priced hand labor.

With the vast bodies of ore in sight in the Butte district, and the great demand and high price for copper as well as from the amicable relations between capital and labor, the outlook for the camp is assuredly a very bright one.

CARE OF MAPS.

How They Should Be Kept—Some Frightful Examples of How They Are and Ought Not to Be.

Written for MINES AND MINERALS, by L. C. M.

An engineer generally regards his maps as a thrifty housewife does her articles of furniture. Anything that can be done to lengthen their life and keep them in good condition is to be commended. It takes a man who has spent several weary weeks on the construction of a map to know how to handle it properly. He has the proper respect for the amount of labor entailed if not of the monetary value of the time consumed, while any one who has been forced to do work on a dirty broken map has it vividly impressed on his memory that a map can not be handled too gently. The life of the maps of any coal company is reduced one-half by the rough usage they are subjected to. This seems to be putting it rather strongly but from an experience of a number of years the writer is inclined to believe it is a conservative estimate. This rough usage of maps comes, in the majority of cases, from the men from whom it would be least expected. That is from the officials, the chiefs of the various departments, the superintendents, men who in nine cases out of ten have advanced from engineer corps and are perfectly familiar with the labor and expense entailed in the making of the maps. They know from personal experience the difficulty and annoyance of trying to do accurate and neat work on a broken or dirty map. With their advancement they seem to forget all this and seemingly have no regard for the handiwork of their successors. It seems as if this was the way the official shows his superiority, his authority to do as he pleases. To cite a typical example. A superintendent comes into the engineering office. He wants to see a map of a particular locality and wants to see it quick. It is brought from the vault. He grabs it. Slams it down on the table. Grasps one end of it near the middle and flings the rest from him. As it unrolls drops a weight on it. He may be a little dusty and his hands dirty but that doesn't make any difference. He flings himself on the map, takes a blunt-pointed pencil of the nondescript variety and proceeds to make a few free handed sketches with possibly an odd calculation or two on it also. Now this man should be perfectly well aware of the damage he is doing. He evidently realizes the

inconvenience he is putting those to who have the mapping to do. Yet he regards his time as being of so much value as to make it perfectly permissible for him to handle the maps so roughly. A few moments of his time—barely a full minute would be required to handle it properly—is worth several years of the maps life. Is worth several hours of some one's time engaged in removing his sketches, calculations, etc., that could as easily have been made on scratch paper and the removal of finger prints or the impression of dusty clothes which but a moment of his valuable time would also have rendered unnecessary. His treatment of the map has a demoralizing influence on all who have witnessed his actions. Their respect for a map is lowered to his estimation of the same, while their treatment of the map will be patterned after his. But the most demoralizing effect will be on the man who has made or is making the map. He has seen it grow under his own hands from a blank piece of paper to the valuable map it now is. He regards it as something of his own, has taken the greatest pains to make it accurate and neat and to keep it clean. Then to see it handled in the disrespectful manner in which it is, maltreated and smudged, finger prints and lead pencil marks on it. He feels that he could hardly be less shocked if the same grimy hand had been placed on the bosom of his shirt. But the worst is he can never regard his map with the same pride he did before. On seeing how his superiors have treated it he becomes less careful in his treatment of it. Not only does it suffer from this lack of care, but what is far more important, less attention is paid to the neatness and accuracy of any additional work put on it.

With the best of care maps will soon show the effects of wear they are subjected to; their edges become frayed and cracked, the ink dim, the paper turns yellow or rather a dirty brown. The frayed edges can be obviated by binding the map. The best form of binding in the writer's experience is a folded gummed binding of some tough cloth, which comes already prepared only requiring moistening to be put on the map. If put on neatly it adds to the appearance of the map, fully protects the edges, and also at the same time protects the work on the map itself. For it forms a slightly elevated track for the map to roll and unroll on, causing less wear or rubbing of the inked surface.

The best possible way to lengthen the life of a map is by means of a tracing of the same, which should be used as much as possible in place of the original. An accurate tracing kept fully up to date will answer the purpose of the original map in nearly all the cases requiring its use. In case of consultation by the various officials it does just as well if not better on account of the less bulk to handle. Minor details and small surveys can be plotted directly upon it. Fifty per cent. of the wear and tear of a map will be taken off of it by the proper use of a tracing. The making of a new tracing bears no comparison to that of making a new map.

A map should as much as possible be in charge of but one man. If he puts on all the work and knows that he is responsible for it all, greater care and neatness will be exercised in putting it on. He will take greater pride in the map, knowing it is all his own handiwork, and not a patch-work of two or three indifferent draftsmen, and the condition of the map will reflect this pride. There is nothing so demoralizing to a map as to have three or four men do work on it promiscuously. Let one man plot the surveys. Have the tracing immediately brought up and it will only be necessary for one man to handle the map. The writer vividly remembers a particularly shocking example of disregard shown a map, which occurred in his apprentice days. It was done by the president of the company and for that reason was made doubly impressive. One of the first lessons impressed on the writer's mind was that a map was something almost holy, only to be approached with the cleanest of hands while a plentiful supply of newspapers protected all surfaces liable to be damaged by contact from the clothing. It was during the absence of the chief engineer, when word was sent up to bring down the map of No. — mine. It was here where the first blunder was committed, instead of taking the tracing of the mine, the message was taken literally and the map itself taken down. The table in the president's room being too small to accommodate the map, he took it and dropped it on the floor (a very dusty matting being on the floor), a grimy handed mine foreman held one end while the president unrolled the map with his foot; and then got on it with his feet, walked all over it pointing out various details with the point of his cane. I have heard of the various impressions left by feet on different substances, the poet tells us a little about it, but the aforesaid poet had never tried to remove No. 9 footprints from a map when he wrote that poem. I spent a day at the job with ill success. Some of those prints were visible for years after. A tracing was made of one of them, and including a detailed account of the occurrence. This was labeled and hung up in the office, while underneath, heavily underscored, was a threat of the most direful punishment of any who tried to follow in the footsteps of the president.

ELECTRIC WIRING IN MINES.

The Difficulties Which Must Necessarily be Met, and Some Means of Reducing the Dangers of Faulty Insulation.

Written for MINES AND MINERALS, by Alton D. Adams.

In but few other places are so many conflicting requirements to be met, as to electric wiring, as in mines. Distances over which the electric energy must be distributed are often so great that comparatively high voltages are necessary to economy in the copper conductors. The higher the voltage of circuits, the greater the necessity for a high degree of insulation, and yet the conditions in mines are such that most wires must be run bare. If wires of comparatively high voltage must be used without an insulating covering, it is desirable that they be erected beyond the easy reach of men and horses, but the head room in mines is often such that this precaution cannot be taken. The large amount of moisture present in a mines renders it very difficult to maintain any high degree of insulation on wires unless they have a covering of rubber, and the sulphur present in the moisture of many mines, especially those of coal, rapidly ruins rubber insulation. The result is that circuits of comparatively low pressure are frequently run with bare wire. A moderate amount of insulation from the earth is obtained at the points of support, by using only large porcelain or glass insulators for the attachment of the wire. Care should be taken to have the wires touch nothing save their insulating supports, and porcelain tubes are convenient in some cases for this purpose, where the sides or ceilings of passages are uneven. Such tubes should also be used in every case where wires go through partitions. With bare copper circuits, in mines where there is much moisture, the most careful work will not ensure a high resistance to earth, because of the films of moisture that collect on the surfaces of the porcelain and glass. While this moisture on insulators is not usually sufficient in amount to cause any serious loss of power, it may well cause a severe shock to one who makes a single contact with the circuit, if his body is also in electrical connection with the ground. The existence of these conditions points to the conclusion that all distribution circuits in mines, should be operated at a voltage that is not ordinarily dangerous to the life of man or beast, so far as possible.

Three kinds of electric service must usually be provided for in mines, lighting, stationary motive power, and hauling. The voltages of circuits for these purposes are apt to vary somewhat according to the kind of electrical supply adopted. The only satisfactory motors available for traction purposes are those of the direct current type. Such motors may be operated at any voltage within wide limits, but the prevailing pressures for railways in mines are 250 and 500 volts. Stationary motors of the direct current type are usually operated at 220 or 500 volts to correspond with generators for incandescent lighting or with the traction system. Satisfactory induction motors operated by two or three phase alternating currents, are now in use. These motors are usually supplied by transformers distant not more than a few hundred feet, and there is therefore, no reason for a voltage higher than 250 on their local circuits. If incandescent lamps are supplied with direct current, the voltage on the two wire system must be about 125 or 250 to correspond with those of lamps. In case the three wire system of distribution is employed for the lamp circuits, their maximum pressures will be twice those just named, or 250 and 500 volts, according to the pressure required at lamps. Lamps on alternating current circuits are usually supplied by comparatively near transformers, and there is slight incentive to use maximum pressures greater than 125 volts on the two wire or 250 volts on the three-wire system.

With these facts, as to the general requirements and limits for electric pressures in mine work, in mind, expedients for greater safety and convenience of operation may be considered. The standard pressure for electric street railway lines all over the country is 500 to 600 volts. The Edison three-wire system of distribution, as extensively used by central stations has very generally employed a pressure of about 250 volts between its outside wires. Experience, gained from these two extensive classes of circuits, has demonstrated that 500 volts is sufficient pressure to readily kill a horse and even a man, when a good contact with both sides of a circuit are made. On the other hand it has been equally well demonstrated that 250 volts will not kill a man under any conditions as to contact that are at all likely to exist in practice, but this conclusion does not follow as to a horse. In mines, where both men and mules are liable to make contacts with live circuits of bare wire, it seems highly desirable that their voltages be limited if possible to 250, and especially that the difference of pressure between either side of any circuit and the ground be not greater than this amount. As above pointed out, there is seldom any good reason for a pressure of more than 250 volts on the alternating current circuits for incandescent lamps

and motors in mines. Direct current distribution to both incandescent lamps and stationary motors may be carried on in mines at maximum pressures of either 250 or 500 volts, with corresponding possible differences of pressure between any wire and the earth of 125 or 250 volts respectively. This result is reached by the expedient, very generally adopted in Edison city systems, of grounding the third or so called neutral wire of the three wire system. Accidental contact is seldom made with more than one electric wire at the same time, and a shock, from one side of a three wire system with a grounded neutral, is given with only one-half of the maximum voltage. The conditions as to the insulation of circuits in mines, as pointed out, are such that the maker of contact with one side of an electric circuit is quite apt to receive the maximum pressure of the circuit unless it has a grounded neutral. The moderate pressures necessary on transformer circuits and the grounded neutral of three wire systems thus greatly reduce the dangers from circuits for lighting and stationary motors in mines.

Most dangerous among electric systems in mines are the trolley or railway circuits. The wires leading to lamps and stationary motors may be grounded, so that a person touching either wire will receive the maximum pressure, though this is not usually as much as 500 volts. There is however some chance of escape without injury from accidental contact, since the ground connections on the lamp or stationary motor circuit may be slight, or the electric pressure of the circuit may be low. One side of the street railway system of electric conductors is however permanently and securely grounded by the use of the track as all or a part of the return circuit. Any one touching the trolley or the uninsulated feed wires is therefore subject to the full difference of pressure between the two sides of the system, if they are in electrical connection with the ground or rails. In places where the pressure on the electric traction system in mines is kept at about 220 volts the probable damage to men or animals is very slight, but repeated and serious injuries have occurred in mines where 500 volts are employed. The very material incentive to the use of the 500 volt traction system is the fact that, compared with a system having 220 volts as a maximum, it saves 75 per cent. of the necessary copper in conductors, all others factors remaining constant. This consideration is of especial weight in those instances where distances are so great that the relative amount of the investment for copper is in any case large. Fortunately however there is a means, though it has not been generally employed for the purpose, by which the advantages of the 500 volt traction system in mines can be retained and at the same time the pressure between the trolley or any of its feeders and the earth or rails limited to 250 volts. This result is reached by applying the three-wire system, long successfully used for lamp and stationary motor circuits, to traction circuits in mines. For this purpose two trolley wires should be used, one connected to each side of the traction generator, or to the free sides of two generators in series. If only one generator is used, the conductors from the rails to the power station should be connected to a small dynamotor, designed to keep the rail pressure halfway between that of the main terminals. If two generators are used in series for the traction lines, then the rail conductors should be taken to their common connection. On a double track road, one trolley wire, representing one side of the system, should be erected over the center of each track, but for a single track road one trolley may be located about over each rail. In this latter case trolley poles should be mounted near one side instead of on the center of cars or locomotives and about one half of them take current from each trolley. This arrangement evidently makes the rails the third or neutral wire of a three-wire system, and any accidental contact between either trolley wire and the rail or ground is exposed to a pressure of 250 volts, when the voltage between the two trolley wires is 500. Contact through accident with both trolley wires at the same instant is improbable, and the three-wire thus offers a decided increase of safety over the two-wire system with 500 volts between trolley and rails. While the low pressure circuits for lamps and stationary motors are quite safe as to their own voltages, there is danger from another source in those cases where these circuits run from alternating current transformers that are supplied by high pressure lines. This danger arises from the fact that a ground connection at any point on the high pressure circuit and a cross between the high and low pressure circuits inside the transformer or elsewhere, exposes one who makes contact from the low pressure to the earth at any point to the voltage of the high pressure circuit. Such an accident would probably result fatally, as the primary alternating lines usually operate at pressures as great as 2,000 or 3,000 volts. This danger can be very largely averted by a substantial and permanent connection between one wire of every secondary circuit and the ground.

If the secondary circuits from transformer are on the two wire plan, either side may be connected to earth, but if they are

run three wire the neutral should be so connected. The connection to ground when properly made is of much lower electrical resistance than the body of a man or animal and the only damage likely to result from a cross between the primary and secondary circuits is a blowing of fuses. The high pressure primary lines to transformers should be kept out of the parts of mines in which work is going on, as far as possible. Rubber covered wires, cotton braided and with a sheath of lead on the outside seem to be the best material for the primary circuits. Where high pressure wires are exposed to mechanical injury, as in vertical shafts, the rubber and lead covering just mentioned should be used and a substantial iron pipe erected, into which the leaded wire is subsequently drawn. It is not necessary to have any lining of insulation for the iron pipes, or to supply insulating supports for it.

Constructing Mine Cross Sections With the Aid of the Pocket Slide Rule.

Written for MINES AND MINERALS, by Leo Gluck, M. E., Butte, Montana

The mining engineer and geologist in the construction and study of cross section of veins by vertical planes of section which are not at right angles to the strike of the vein and therefore do not show the true dip of the vein in the cross section, but instead show an apparent dip, must solve the problem of finding the dip of the line of intersection of a vertical plane (section plane),

whose strike is known, with an inclined plane (vein plane) whose strike is also given.

The converse of this problem where the dip of the line of intersection is known from the cross section, and knowing the strike of the section plane and also the strike of vein plane from the plan map, to find the true dip of the vein.

In Fig. 1, ABC represents the strike of the vein plane $ABC'G'F'D'$, its true dip being $FB'F'$ or $B'F'B' = d$. DBE represents the strike of the vertical section plane $DBE'E'B'D'$ then EBC or $E'B'C'$ or $F'D'$

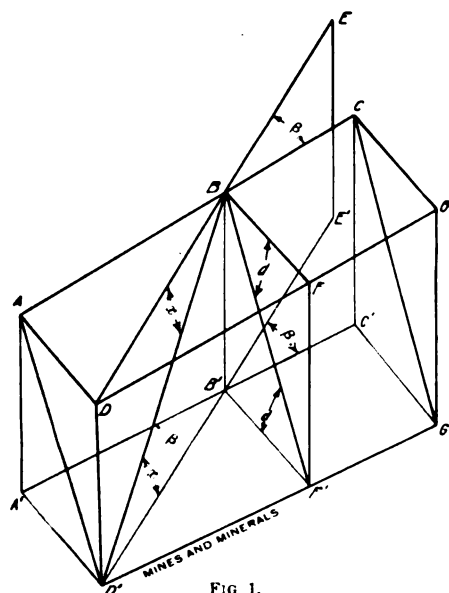


FIG. 1.

$B' = \beta$ or the included angle of the strike directions.

The problem to be solved is the following: Given the direction of strike of the vertical section plane and of the vein plane and thereby fixing the angle β , the vein plane having a true dip of " d "; to find the "apparent dip" angle " x " of the intersection of the two planes in question.

From Fig. 1, the trigonometric solution is as follows:

$$(1) \quad \tan d = \frac{B'F'}{B'B'} \text{ or } B'B' = (\tan d) B'F'.$$

$$(2) \quad \tan x = \frac{B'F'}{D'B'} \text{ or } D'B' = (\tan x) D'F'.$$

Combining (1) and (2),

$$(3) \quad \tan x = \tan d \left(\frac{B'F'}{D'F'} \right).$$

$$(4) \quad \text{But } \frac{B'F'}{D'F'} = \sin \beta;$$

therefore substituting (4) in (3)

$$(5) \quad \tan x = \tan d \sin \beta.$$

If β and x were given to find the true dip d formula (5) is transposed into (6) $\tan d = \frac{\tan x}{\sin \beta}$

The value of the simple formulae (5) and (6) in the solution of problems in question is usually not made use of for the reason of the time required in looking up the natural sines and tangents, their multiplication or division and the finding of the angle corresponding to their product or quotient; or if logarithms are used a corresponding time is required for the solution.

The writer has found that the ordinary "Mannheim" pocket slide rule can be very advantageously used for the rapid and accurate solution of these problems, even though requiring extra

movements, which, however, can be quickly performed, due to the fact of its being graduated for other purposes than called for in these problems. The writer by especially designing the slide rule, as described later, has reduced the number of movements and therefore also the time for the operation of the multiplication of a sine by a tangent; or the division by a tangent.

The top of the slide BB Fig. 2 is graduated to the right for sines to 90 degrees and correspondingly the natural sines to 90° are immediately above on the rule AA .

The bottom of the slide CC is graduated to the right for tangents to 45°; and can, for angles greater than 45°, be read to the left; correspondingly below on the rule DD the natural tangents of the same.

The operation of the solution of $\tan x = \tan d \sin \beta$ is as follows:

First bring the fixed indexes of the rule and slide together, then on BB find the sine given and mark the same by the movable index, reading the same off on AA .

Find the corresponding number on DD and mark the same by the movable index, then move the slide CC say to the left until the fixed index coincides with the movable index; move the movable index and read the given tangent on CC without disturbing the movable index. Bring the slide into its initial position of having the fixed indexes together, then read off the required angle on the Tangent scale on slide CC marked by the movable index.

If the given tangent is greater than 45°; subtract the same from 90° and the operation is then as follows:

Bring all the fixed indexes together and as before transfer and fix the natural sine reading to DD by the movable index. Read the tangent subtracted from 90° on the slide CC , making it coincide with the movable index. The final reading is obtained on CC where CC coincides with the right fixed index of DD .

The transferring of the sine from BB to AA and then to DD can be avoided by graduating the slide rule especially. Instead of the graduations reading natural tangents on rule DD the same can be graduated to read the natural sines corresponding to the tangent values

on CC . The problems then in question require only the slide graduated for tangents on CC and for sines on DD thereby saving the transfers from BB scale to AA and then to DD beside eliminating the use of AA and BB scales entirely, thus simplifying the slide rule for the special purpose.

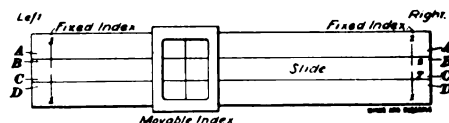


FIG. 2.

Alabama Coal Production.

As Alabama is the fifth largest coal-producing State in the Union, and as its production increased from 5,893,770 tons in 1897 to 7,484,783 tons in 1899, with an estimated production of 10,000,000 tons for 1900, it would seem that there will be not only a sufficient amount produced to supply all demand in the State, but a generous product for export. Such was the case up to within the past two years, but in that time Alabama had forged to the front as a great iron-producing State, and the tremendous demands for iron in all of its forms has given such an impetus to the iron industries as to cause an unprecedented demand for coal for coking purposes, and any surplus that previous years may have shown has vanished. The opening up of thousands of coke ovens has made necessary also the opening up of new coal mines in order to supply this increased demand for coal by the iron industry alone.

In addition to these, many large manufacturing plants have been erected within the past year, not only in Alabama but in sections of other States near the coal fields, and extensive additions have been made to old plants. All of these depend on Alabama coals for steam purposes, and have added largely to the State production. In Alabama alone 52 cotton mills are now in operation, with several new ones in course of erection, to be completed by October 1, 1900.

Another factor is the increased demand by railroads, made necessary not only on account of the building of new lines, but by the increased commerce extended to them from the different industries, as well as from the general building up of the State.

Though the receipts at Mobile exceeded those of any previous year, yet the bulk of the coal has been barely sufficient to supply the home demand, leaving only 4,770 tons to be applied to export orders, which orders have aggregated several hundred thousand tons. Outside of exporting coal, Mobile's business consists largely in supplying steamers with bunker coal. This branch of the trade in the past year has shown a considerable increase, 372 steamers having entered the port of Mobile in six months.—*Twenty-second Annual Report U. S. Geological Survey.*

Mines and Minerals

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THE WORLD'S MINERAL PRODUCTION.

THE accompanying illustrations, which are reduced from large diagrams prepared by Mr. E. W. Parker, Statistician of the United States Geological Survey, Washington, D. C., for the Paris Exposition and reproduced through his courtesy, show graphically and very strikingly the preeminent place occupied by the United States as a mineral producer. In these diagrams the height of the Eiffel tower is taken as the measuring stick, and with this enormous measuring stick immediately before the eyes of all visitors to the Exposition the immensity and magnitude of our mineral resources have undoubtedly been most powerfully and strikingly impressed upon all foreign nations.

At the present time the greatest interest naturally centers in the coal production, and although the output of England for the year 1899 was not available when these diagrams were made up it will be remembered that these figures which have already been printed in detail in MINES AND MINERALS show the United States to have been an even more preeminent leader during the year 1899 when for the first time they passed Great Britain as a coal producer.

Having once assumed this leadership in coal production it seems scarcely possible that the position will be given up, at least, for many years to come, for as we have previously pointed out in editorials in the April and July issues of MINES AND MINERALS the rate of increase in coal production upon the part of the United States has been so very much more rapid than in all the other countries that there is little possibility that Great Britain will again assume the lead.

The principal theme for discussion now is to what extent the United States will enter upon the European market. The English mining journals are trying to bolster up the spirits of the English coal producers by depreciating the value and extent of the amount of coal exported from the United States for some years past. To be sure this amount has been small compared with the much larger amount exported from England, but if the present activity continues and if the market for coal holds out as it gives promise of doing, there will undoubtedly be a great increase in exports. There are two reasons why this has not occurred heretofore. First, the enormous demand for coal within our own borders has absorbed the surplus. Second, and chiefly, the lack of transportation facilities. This second reason cannot be immediately remedied, of course, but if it were not for the fact that at the present time a great number of the ordinary ocean carriers have been taken from other regular trade by the war interests in South Africa, China and the Philippines, the export of coal from the United States during the year 1900 would undoubtedly have been a very greatly increased quantity.

This subject of transportation is being carefully investigated by some of the largest producers and transporters of bituminous coal, as well as by the individual anthracite operators, and if as a result of this investigation it can be shown that the European market will probably be a constant one, the lack of transportation facilities will undoubtedly be quickly remedied.

The problem of the transportation of iron ores from the Lake Superior mines to the East was solved through the invention of the whaleback, and this, together with the wonderfully economical handling of both ore and coal, has greatly reduced the cost of carrying these commodities through the great lakes. If the demand is sufficient, it is quite probable that some form of ocean whaleback or similar device will be brought out and a new method of transatlantic transportation thus furnished. It is matter of history, and not simply American pride and boasting as some would have us think, to say that every similar commercial and industrial problem of this kind has been promptly and successfully met, and it seems only reasonable to argue and to believe that this bridge of costly transportation will be crossed and put out of the way as soon as there is a real necessity for its being done.

The position of the United States as a producer of pig iron is

very well shown by the second portion of the diagram and when we remember that it was only in 1890 that we first passed Great Britain in this respect, the rapid increase which has since been made will be better appreciated, and in this item the end is not yet, for the steel works of the country are constantly getting into better form for increased production.

In petroleum we must yield second place to Russia, but compared with the rest of the world our barrel is seen to be of very much greater capacity than that of the barrels of all countries of the world excepting Russia.

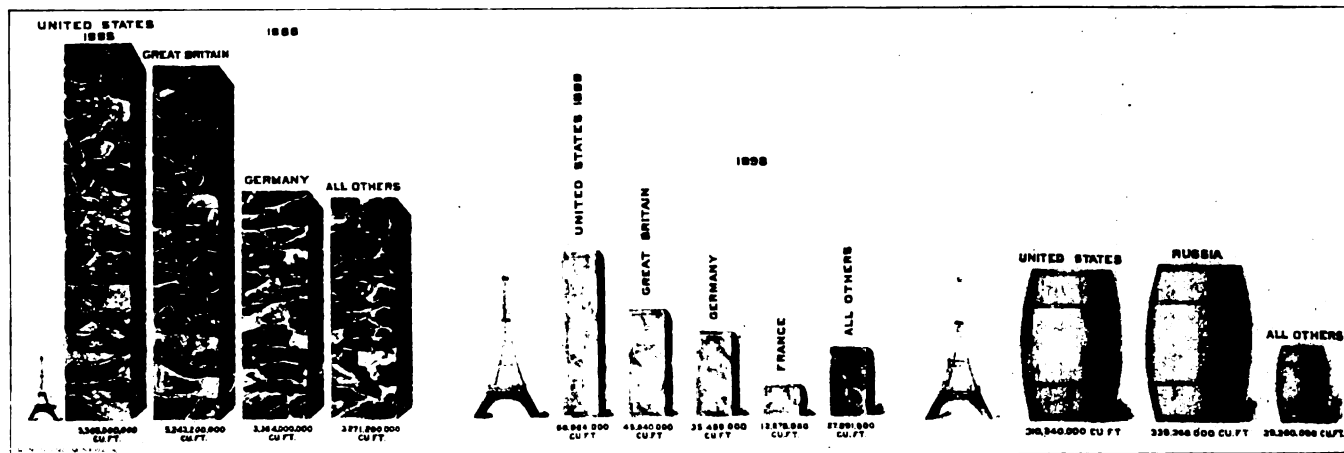
number of years, we have to bow the knee to both Africa and Australasia. It is a striking fact that these three greatest producers are all English speaking countries so that the honor of producing nearly all of the world's wealth is kept within the family, for the amount produced by all other countries is very small compared with that produced in Africa, South Africa, Australia, Canada, and the United States.

Probably the most striking table is that of the total mineral production, which shows the United States to be preeminently the mineral producer of the world. In the light of the increase

WORLD'S PRODUCTION OF COAL.

WORLD'S PRODUCTION OF PIG IRON.

WORLD'S PRODUCTION OF PETROLEUM, 1898.

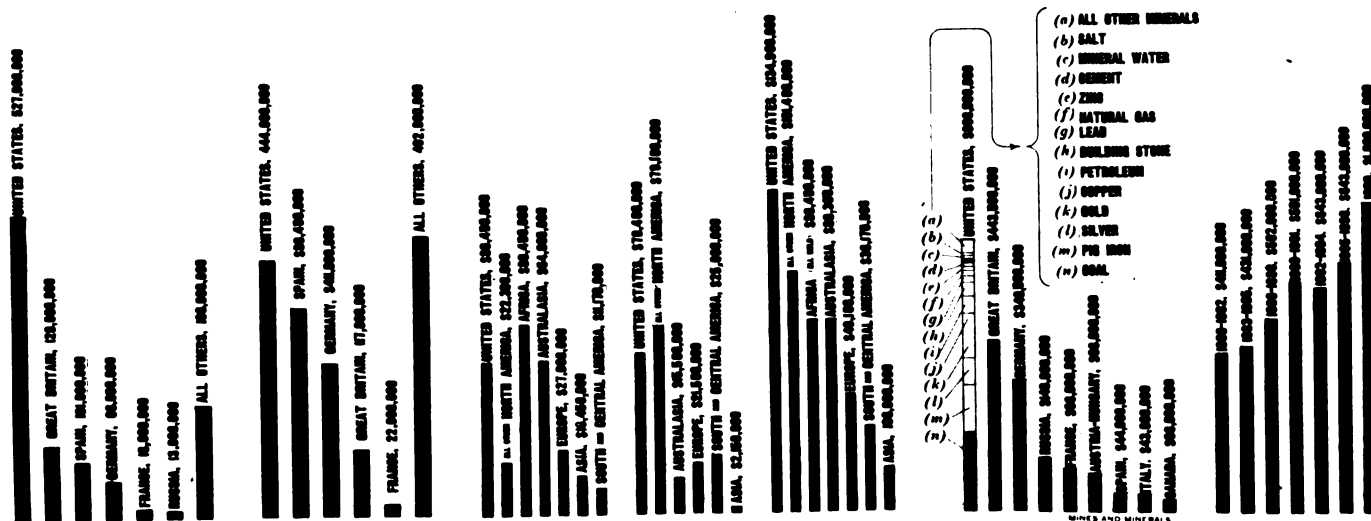


WORLD'S PRODUCTION OF COPPER AND LEAD. Figures indicate pounds.

WORLD'S PRODUCTION OF GOLD AND SILVER, 1898. GOLD. SILVER. (Coining Value.) TOTAL.

TOTAL VALUE OF MINERAL PRODUCTION IN PRINCIPAL COUNTRIES OF THE WORLD, 1898.

AVERAGE TRI-YEARLY VALUE OF THE MINERAL PRODUCTION OF THE UNITED STATES, 1880-1898.



GRAPHIC ILLUSTRATIONS OF THE MINERAL PRODUCTION OF VARIOUS COUNTRIES OF THE WORLD.

Compiled from official sources by Edward W. Parker, Statistician U. S. Geological Survey.

A most striking feature of the chart is the prominent place of the United States in the production of copper, of which metal we produce nearly three times as much as all others combined.

In the production of lead we lead all others, but have quite close seconds in Spain and Germany which will probably continue to be large producers for years to come. Our lead resources, are, however, of great magnitude and the amount of output will probably be limited only by the demand. With the many lead mines already found the output can be very quickly and materially increased should there be the demand for it.

In the production of gold, where we held preeminence for a

number of years, we have to bow the knee to both Africa and Australasia. It is a striking fact that these three greatest producers are all English speaking countries so that the honor of producing nearly all of the world's wealth is kept within the family, for the amount produced by all other countries is very small compared with that produced in Africa, South Africa, Australia, Canada, and the United States.

A consideration of the accompanying tables is not only a source of national pride and satisfaction, but it is a great encouragement in showing that our business is based upon a very solid foundation.

SOLUTION OF TRUST PROBLEMS.

THE Iron Trade Review for September 13, 1900, contained the following very sound reasoning upon the subject of trusts.

"That the trust question is settling itself out of politics, as some of the best students of the problem have insisted it would, appears both from the falling off in the trust-making industry and the rapid declines in trust stocks. In August, as the returns show, New Jersey, West Virginia and Delaware, which lead in the incorporation of trusts, had only a \$68,000,000 total for the capitalization of new companies, \$23,000,000 for New Jersey, \$43,000,000 for West Virginia and \$2,000,000 for Delaware. These amounts include a considerable capitalization of companies other than consolidations. The contrast is very sharp between August and the first two months of last year, for example. In January and February, 1899, the consolidation charters in New Jersey alone showed an aggregate of \$1,048,800,000 in stocks and \$57,500,000 in bonds. This was in comparison with \$916,176,000 of trust capitalization in the same State for the entire year 1898. It is very evident that the craze has subsided into very tame proportions since the early months of July.

Taking another phase of the anti-trust agitation, and the alarmist predictions are also being greatly modified by events. If we may judge from the iron trade, the fear that competition will be destroyed is quite baseless. The independent production of tin plate, wire products, hoops, and bar iron is greater today than at any time since the companies devoted to those special lines were organized, and in each of them more mills are building and will be in operation in the coming year. Prices of these products, which were high last year, not because of the combines, but because everything in iron and steel was in demand beyond the ability of producers to respond, are now low enough to suit the most rabid hater of trusts. Certainly there is no brilliant showing under today's market, for dividends on common stocks, which stand for much of the water that has most disturbed the foes of the combines. That "water" seeks its level, whether in hydraulic systems or in trust stocks, has been plainly demonstrated by the course of the stock market in the past 12 months. For nine well known iron and steel issues the figures are instructive. American Steel & Wire, American Steel Hoop, American Tin Plate, American Car & Foundry, National Steel, Federal Steel, Pressed Steel Car, Republic Iron & Steel and Tennessee Coal Iron & Railroad Co., whose combined issues represent \$480,654,200 showed a decline in market values between Aug. 26, 1899, and Aug. 27, 1900, of \$93,600,037. In most of the stocks named the decline on the preferred and common issues combined ranged from 30 to 45 points. At the prices quoted late in August or at any time in the last two weeks, those who complain of the enormous profits of the consolidations should find opportunities for uncommonly profitable investment. This opportunity, moreover, is open to all comers, and if the critics of the trusts on the score of unwarranted profits have the courage of their convictions they will not neglect the opportunities that are now freely offered in Wall street. As for the underwriters of many of the combines, they will no doubt even now part with much of their holdings at a liberal discount from the ground-floor price. Shrinkages all the way from 10 to 64 points from the original underwriting basis have taken place in well known consolidation stocks.

Up to date the chief sufferers from the combines are those who had most confidence in their securities. The public is being guarded by the operation of natural laws as certain as the processes of the sun.

A. de Kappen has collated the following accident statistics of various foreign countries, which show that in coal-mining the average of fatal accidents per 1,000 miners was as follows:

	1886-1890.	1891-1895.
Germany	2.566	2.450
Russia	2.44	2.522
France	2.105	1.665
Great Britain	1.835	1.526
Belgium	1.754	1.665
Austria	1.548	2.389

Book Review.

BULLETIN No. 61 OF THE AGRICULTURAL EXPERIMENT STATION OF LOUISIANA, William C. Stubbs, Ph. D., Director. Subject, Rice. Pamphlet 59 pages.

TRANSACTIONS OF THE NEW SOUTH WALES CHAMBER OF MINES, August, 1900, Vol. 1, No. 5. Published by the Chamber, Sydney, New South Wales. Price 6d.

JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES, Vol. XXXIII. 1899. Published by the Society, 5 Elizabeth St., Sydney, 227 pages.

SETTLERS' EXPERIENCE IN KERN COUNTY, CAL. as related by themselves with advice to newcomers. Pamphlet 58 pages. Published at Bakersfield, Kern Co., Cal.

GENERAL REPORT AND STATISTICS FOR THE MINES AND QUARRIES OF GREAT BRITAIN, PART 2, LABOR, edited by C. Le Neve Foster, Inspector of Mines, London, Eng. Pamphlet 115 pages.

MONTHLY SUMMARY OF COMMERCE AND FINANCE, AUGUST 1900. 257 pages. This number contains an interesting and quite elaborate article upon the iron and steel trades of the United States.

CALIFORNIA ITS ATTRACTIONS FOR THE INVALID, TOURIST, CAPITALIST AND HOMESEEKER, pamphlet 47 pages. Published by Jerome Madden, Land Agent, Southern Pacific Railroad, San Francisco, Cal.

THE IMPERIAL PHYSICO-TECHNICAL INSTITUTION IN CHARLOTTENBURG by Henry S. Carhart. A paper read before the 146th Meeting of the American Institute of Electrical Engineers, New York, September, 1900. Pamphlet 19 pages.

COAL TRADE OF THE UNITED STATES. THE WORLD'S COAL SUPPLY AND TRADE. BULLETIN OF THE TREASURY DEPARTMENT, BUREAU OF STATISTICS, Washington, D. C. 110 pages. A very interesting statistical account of the development and growth of coal trade in the United States.

ANNUAL REPORT OF THE SECRETARY OF INTERNAL AFFAIRS OF THE COMMONWEALTH OF PENNSYLVANIA by James W. Latta, Secretary of Internal Affairs; James M. Clark, Chief of the Bureau, Harrisburg, Pa. 580 pages illustrated. In addition to the usual statistics this Report contains a very well illustrated account of the cotton goods industry.

PRACTICAL NOTES ON HYDRAULIC MINING by George H. Evans M. E. second edition published by John Taylor & Co., San Francisco, Cal. 48 pages, price \$1.00. The first edition of this book appeared some three years ago and so successful was it that a second edition has been required. Mr. Evans has put into this small volume a large amount of interesting and valuable hydraulic data drawn from his wide experience in this particular field of mining.

BULLETIN OF THE UNIVERSITY OF KANSAS, Vol. 1, Part 3. Pamphlet, 165 pages with a number of excellent plates. Published by the University of Kansas, Lawrence, Kansas. The typography of the book is most excellent. Its contents include the following: Coccidae of Kansas; The Stratigraphy and Invertebrate Faunas of the Jurassic Formation in the Freeze-Out Hills of Wyoming; the Spermatogonial Division in Brachystola Magna; Annotated List of the Minerals Occurring in the Joplin Lead and Zinc District.

MINERAL RESOURCES OF KANSAS FOR 1899, by Erasmus Haworth, Department of Physical Geology and Mineralogy, University of Kansas, Lawrence, Kansas. 67 pages. This bulletin though short is excellently gotten out and shows the same careful work that has been done by Prof. Haworth in previous volumes. The scope of the book is shown by the following chapter headings: Gold and Silver; Lead and Zinc; Coal; Oil and Gas; Gypsum and Gypsum Cement; Plaster; Building and Other Stone; Clay Products; Hydraulic Cement; Salt.

TRANSACTIONS OF THE AUSTRALIAN INSTITUTE OF MINING ENGINEERS, Vol. VI, edited by A. S. Kenyon, Secretary, Melbourne, Australia. 247 pages. The papers contained in this report are the following: Safety Appliances and Precautions Necessary in Mines, by J. R. Godfrey; Contacts, by W. H. Ferguson; Some Notes on Dry Crushing, by N. F. White; Contouring on Mining Properties with the Aid of the Tacheometer, by H. P. Seale; Diamond Mines and Alluvial Deposits, by P. R. Day; The Manufacture of Sulphuric Acid and Its Use in Metallurgy, by W. H. Mawdsley; Mine Stores, by F. Danvers Powers; The Use of Electricity in Mining, by E. F. J. Holcombe Hewlett.

BULLETINS OF THE UNITED STATES GEOLOGICAL SURVEY, Washington, D. C. The Production of Mineral Paints and Barytes in 1899, by E. W. Parker, 24 pages; Production of Soapstone in 1899, by E. W. Parker, 8 pages; Production of Asbestos and Graphite in 1899, by E. W. Parker, 12 pages; Production of Mineral Waters in 1899, by A. C. Peale, 30 pages; Production

of Abrasive Materials in 1899, by E. W. Parker, 21 pages; Production of Manganese Ores in 1899, by John Birkinbine, 38 pages; Production of Gypsum in 1899, by E. W. Parker, 12 pages; The American and Foreign Iron Trades in 1899, by James M. Swank; Production of Coal in 1899, by E. W. Parker, 203 pages.

MISSOURI GEOLOGICAL SURVEY, Vol. 13, preliminary report John A. Gallaher, State Geologist, Office of the Missouri Geological Survey, Jefferson City, Mo. 259 pages. This volume is divided into two parts. Part 1 is made up of the following chapters: The Synthetic Method of Nature; The Primordial Shell of the Earth; The Geological Record. Part 2 is composed of the following: The Primordial Base; The Geological Record; Cambrian Division; Ordovician Division; Silurian Division; Devonian Division; Subcarboniferous; Lower Coal Measures; Middle Coal Measures; Upper Coal Measures; Forest City Lens; Tertiary, Glacial Drift, River Loess, Soils, and Forestry; Chemical Analysis.

ELEMENTS OF MINERALOGY, CRYSTALLOGRAPHY AND BLOWPIPE ANALYSIS, by Alfred J. Moses, Ph. D., and Charles Lathrop Parsons, B. S., published by D. Van Nostrand Co., New York City, 409 pages, price \$2.00. Part 1 on Crystallography has been entirely rewritten and made to conform to the present special classification. Over 100 additional figures have been added to the text. Part 2 on Blowpipe Analysis has been revised and additional sections upon the use of the spectroscopic and of metallic sodium added. Part 3 contains an introduction to the later study of thin sections of minerals with the microscope. Part 4 on Determinative Mineralogy has been considerably simplified.

IOWA GEOLOGICAL SURVEY, Vol. 10, Annual Report for 1899. Samuel Calvin, A. M., Ph. D., State Geologist. Published by the Iowa Geological Survey, Des Moines, Iowa. 666 pages. The scope of this report is shown by the following table of contents: Administrative Reports; Statistics of Mineral Production; Fossil Fauna of the Kinderhook Beds of Burlington; Geology of Lyon and Sioux Counties; Geology of Osceola and Dickinson Counties; Geology of Hardin County; Geology of Worth County; Geology of Dubuque County. The value of the mineral production in the State during the year is as follows: Coal, \$6,137,576; Clay (estimated), \$2,500,000; Stone, \$809,924; Gypsum (estimated), \$600,000; Lead and Zinc, \$50,542; Iron Ore, \$3,465; total \$10,101,507.

VICTORIA JUBILEE BRIDGE. We have received with the compliments of the Grand Trunk Railway System a splendid souvenir of the Victoria Jubilee Bridge across the St. Lawrence River, which was opened for traffic December 13th, 1898. The volume is beautifully printed on plate paper, illustrated by excellent photographs, and is a complete description of the new bridge and the ceremonies attending its opening; of the old method of reaching Montreal by ferry from Longueuil in 1855; of the old tubular bridge built in 1860, which was replaced by the new one, etc., etc. The volume is a work of art in every respect, and is beautifully bound in an engraved aluminum cover. The Victoria Jubilee Bridge now in use in crossing the St. Lawrence River is one of the best pieces of modern engineering work in America, and its construction by the Grand Trunk Railway System will prove an important factor in the future development and industrial growth of the beautiful City of Montreal and the Province of Quebec.

JOURNAL OF THE CANADIAN MINING INSTITUTE FOR 1900, edited by the Secretary, Mr. B. T. A. Bell, Ottawa, Can. The papers contained in this report are the following many of which have already appeared in the several technical papers. Notes on the Ymir Mine and Its Mill Practice, by Mr. S. S. Fowler; The Small Economies in Mining, by Howard West; The Bridge River Gold Mining Camp, by Fritz Cirkel; The Chicago Main Drainage Channel, by Mr. James F. Lewis; A Method of Cost Accounting with Special Reference to Mines, by Mr. John E. Hardman; Natural Gas in Ontario, by Mr. Eugene Coste; A Prospecting Trip in Northern Omenica, B. C., by Mr. E. C. Gwillim; The Factors in Concentration; The Ontario Mining Law, by Mr. J. M. Clark; The Iron Industry in 1899, by Mr. George E. Drummond; The Old Valley Gravels of the Klondike, Mr. R. G. McConnell; Results in the Use of a Rotary Pump as Against Straight Line Type, Mr. W. Charles Fergie; Notes on Increased Facilities at Wabana Iron Mine, by Mr. R. E. Chambers; Recent Advances in Electro-Chemistry and Electro-Metallurgy, by Dr. W. L. Goodwin; West Kootenay Notes, by R. W. Brock; Mining Pumps, by C. E. Morgan; Are There Diamonds in Ontario? by Mr. A. Blue. One of the most interesting papers is that by Mr. John E. Hardman entitled Method of Cost Accounting with Special Reference to Mines.

A PRACTICAL COURSE IN THE FIRE ASSAYING FOR GOLD, SILVER, AND LEAD OF ORES, BULLION, AND METALLURGICAL PRODUCTS, by Ernest H. Simonds. 92 pages. A separate-leaf note book for students' use in the laboratory and furnace room. Under the head of "General Directions and Suggestions," the author enumerates the principal errors which may enter the results in fire assaying, giving their causes and effects, and showing how such errors may be minimized, and in some cases entirely elimi-

inated by careful systematic work. In "Assignment" 1 the theory, construction, and use of the balance are explained in detail, and examples given for practice in accurate weighing. Assignment 2 treats of miscellaneous mechanical operations such as making cupels, repairing furnaces, rolling out bullion, etc. The remainder of the book is devoted to instruction in assaying proper. Using two well known works on assaying as textbooks and giving numerous valuable references, the author explains and discusses many of the best methods of fire assaying for gold, silver, and lead.

REPORT OF THE BUREAU OF MINES OF PENNSYLVANIA FOR 1899, Part 5 of the Report of the Pennsylvania Department of Internal Affairs. Jas. E. Roderick, Chief of the Bureau of Mines, Harrisburg, Pa. 958 pages. This volume contains detailed statistics and reports from each of the 8 anthracite districts and the 10 bituminous districts of the State of Pennsylvania. There is nothing new or striking in the method of presentation of these reports excepting that the attempt has been made to secure additional technical statistics. In the anthracite region the number of boilers in use is given, the locomotives and whether they are steam or electric; the number and capacity of pumps; the number of electric dynamos and air compressors. In the bituminous region statistics have been gathered under the same headings and in addition data have been compiled showing the character of the appliances for furnishing ventilation, the character of opening in a mine, whether drift, slope or shaft; the mines at which mining machines are in use; the type of machine used and the character of the haulage. This is an interesting and valuable addition to the reports of previous years and should be undertaken for the anthracite as well as the bituminous regions. Reports for the several districts should be presented in a uniform form and summaries should be compiled showing in a condensed form the statistics thus collected.

The Chief of the Bureau in his introduction speaks very highly of the mine inspection service of the State and he says very truly that it is in general being very carefully and conscientiously carried out. The volume is almost twice as large as the preceding one and it is rapidly growing to be a bulky, unhandy volume to handle. This is largely due to very loose open printing in the tabular portions of the book which might be very greatly condensed with advantage to the reader. A proper index would also greatly add to the usefulness of the volume. The present index in the back of the book is merely a table of contents misplaced as no attempt has been made at an alphabetical arrangement.

It seems to have become a settled custom for these reports to be very much belated and the present one has even surpassed those for several years past by appearing nine months after the close of the year for which the report is given. Wherever the fault lies for this lateness it should surely be corrected, for now that the State has a distinct Bureau of Mines, the mining industry has a right to expect that these reports should be issued in time to be of some practical value, as statistical reports are intended for current information and not as historical reference books.

John M. Desloge.

John M. Desloge was born April, 1849, at Potosi, Washington Co., Mo. He finished his education at the St. Louis High School, taking up the profession of mining. His first operation was in the lead business, as Assistant Superintendent of the Desloge Lead Co.'s Works at Bonne Terre, Mo. Here he remained up to the time of the transfer of the mine and plant in 1886 to the St. Joseph Lead Co. From there he went West and spent a large portion of his time in the examination and development of mining properties at various places. In 1891 he accepted the position of Supt. of the Desloge Consolidated Lead Co., developing the mining property and finally erecting the works and mining plant as now in operation. His death on Sept. 7, 1900, was a great loss to his family and friends and deprives the mining world of one of its brightest members.

In a recent paper on Mechanical Draft read before the New England Cotton Manufacturers' Association Walter B. Snow states that from a comparison of a considerable number of plants it appears that under ordinary conditions; a single forced-draft fan with direct-connected engine and short stack can be installed for less than 20 per cent of the cost of a brick chimney. A single induced-draft fan with direct-connected engine and short stack will cost less than 30 per cent of a chimney; and that a duplex induced-draft apparatus consisting of two fans with direct-connected engines inlet and outlet connections and short stack will cost but little more than 40 per cent of a chimney. The latter arrangement is only employed where as in the case of an electric lighting plant, it is the practice to introduce relay units.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Gypsum or Plaster of Paris.

Editor Mines and Minerals:

SIR:—Kindly inform me where I can find information upon the consumption of plaster of Paris in the United States, its average selling price, and the method used in its manufacture.

Cleveland, Ohio.

G. F. L.

ANS.—The gypsum statistics for the United States during 1899 are contained in the Report of the United States Geological Survey, Division of Mineral Resources, just issued, under title of "The Production of Gypsum in 1899," by Mr. E. W. Parker. This report shows that during 1899, 327,879 short tons of gypsum were ground into plaster of Paris, producing 248,723 tons of calcined plaster, of which the average value was \$3.49 per ton. The method of preparing plaster of Paris is to grind the crude gypsum to a fine powder and then to calcine it at a high temperature in a suitably constructed kettle until the water contained in the gypsum has been expelled. Probably the best work on this subject of gypsum is Vol. 5 of the University Geological Survey of Kansas Reports. An article upon the subject of gypsum and its manufacture into plaster of Paris will appear in MINES AND MINERALS at an early date.

Prospector.

Editor Mines and Minerals:

SIR:—A friend of mine, some years ago, located a mining claim in southern Colorado, and opened up a body of talc in which were imbedded angular pieces of the country rock, which he described as porphyry, quite angular, and boulders of quartz, quite round. The talc was very tough, and could not be shoveled, picked or blasted, to any advantage. The talc when dry could be pounded fine and panned. The result being a lot of small shot from the size of birdshot to a buckshot, of a color a little lighter than lead, very malleable, and about as soft as lead. No assays were ever made, and samples were lost. Would like very much if you could tell me what the metal was.

Yours truly,

Colo. Springs, Colo.

A. S. HOWELL.

This is a somewhat hard question to answer. Talc is a very indefinite and incorrect term used by miners. It generally means with them any soft, decomposed rock such as is produced by kaolinization of the felspar, especially in granite, porphyries and similar rocks. The term "porphyry" is equally dubious as used by the miners, it may have been a true porphyritic rock or only decomposed granite.

As regards the malleable metal found, if it was not lead it is hard to say what it may have been. We can only suggest molybdenum (?). If it assayed very highly, it might be possibly some of the sulphides of silver (?), or horn silver (?), or wire silver (?), but these are not malleable. This question cannot be answered without seeing the samples.

A. LAKES.

Location of Mineral Claims on Railroad Lands.

Editor Mines and Minerals:

SIR:—Will you please inform me through the columns of your paper what steps should be taken in order to locate a mineral claim on railroad lands?

Temescal, Cal.

"PROSPECTOR."

The location "of mineral claims on railroad lands" differs in no respect from the location of such claims upon the public domain; that is, that lands within the limits of the grants to railroad companies known to contain mineral prior to the issuance of patent to railroad companies are subject to location and entry, as in other cases. If, however, patent to a railroad company has issued for such lands, they are no longer public domain and the general land office has no jurisdiction over the same.

A further answer to the above inquiry has been received as follows:

Editor Mines and Minerals:

SIR:—I have yours of the 24th inst. asking for information regarding steps necessary to be taken to locate mineral claims upon railroad lands in this state.

The Southern Pacific Railroad Co. has patent for a large quantity of land, on some of which oil has been found, and some

of which is supposed to contain oil. These lands have been reserved from sale, but the company issues oil development leases on certain portions of them, generally for 160 acres, in 40-acre tracts, to those who desire to go into that business. It has issued a number of them thus far. The conditions are that during the first year the lessee must sink a well on each of the tracts he has leased, to a depth of 2,000 feet or until oil is found at a less depth in paying quantities (10 barrels per day of 24 hours), and that one well shall be sunk on each tract each year thereafter, until four wells are sunk on the respective tracts. The lease runs for 10 years, with privilege of ten more on same terms. The royalty is one-eighth of the gross proceeds. The lessee as a guarantee of good faith must pay, before lease will be issued, \$250 to insure performance of first year's work, and \$8 additional for R. R. acknowledgements, revenue stamps on lease, and recording same. The \$250 will be given back at the end of the first year if the terms of the lease are complied with, otherwise this amount will be forfeited to the R. R. Co.

The company has also large quantities of agricultural lands, at prices ranging from \$2.50 to about \$10 an acre.

Yours truly,

JEROME MADDEN,

Land Agent Southern Pacific R. R.

The Rock Lake Concentrator.

The Rock Lake Mining Co. Ltd., whose office is in Sault Ste. Marie has a copper property situated in the District of Algoma, Province of Ontario, Dominion of Canada, about 35 miles east of Sault Ste. Marie and 9 miles due north of Bruce Mines station on the Canadian Pacific Railroad. This is a copper property and a concentrator has recently been built which is described by the designer as follows:

"The Rock Lake 200-ton concentrator is situated on a suitable side hill of 21 degrees slope on the shores of Rock Lake. It is adjacent to the vein and handy to the lake for water transportation to railway, thereby shortening very considerably the distance concentrates or matte must be teamed. The crude ore from mine is dumped into storage bins so placed at the head of the mill that the ore will fall by gravity into a 20 in. $\times$ 30 in. Blake crusher. The product from the crusher all passes to a 1 in. mesh revolving screen or trommel, the oversize from this trommel going to a set of 16 in. $\times$ 30 in. belt-driven rolls. These rolls are provided with adjustable ball and socket bearings to prevent cramping and consequent wear to shafts. From these rolls the ore is elevated to the above mentioned trommel so that all ore passing to mill has to go through its preparations.

"From this trommel the ore passes to the line of 4 sizing screens, the preparation of these screens being $\frac{7}{8}$ in., $\frac{3}{4}$ in., $\frac{1}{2}$ in. and $\frac{1}{4}$ in., respectively. The oversize from the $\frac{7}{8}$ in. revolving screen is delivered to a coarse jig of special design having plungers provided with parallel motion. The oversize from the other revolving screens is also delivered to jigs having screens to suit the various sizes of ore, and the last screenings from the finest trommel run to a settling tank to be treated on still finer jigs. The middlings from jigs are crushed in another set of 16" $\times$ 30" rolls and elevated into the string of trommels again for sizing and distribution.

"The tailings from jigs are led to a set of high speed 6 in. $\times$ 48 in. rolls, then elevated to a settling tank and fed over Wilfley tables. All material fed on Wilfleys is first sized in a patented sizer where the pulp is thrown by centrifugal force against a screen of 18 mesh to the inch, the oversize being led back to the high speed rolls. Concentrates from jigs and tables are spouted down the mill and settled in large bins from which they will be delivered to smelter. Adjacent to the mill is an engine and boiler room 38 ft. $\times$ 64 ft., in which are placed a 250 H. P. tandem condensing Corliss engine, and 3 tubular boilers of 80 H. P. each, this power plant being amply large enough to furnish the mill with electric light and also drive the mill at a considerably increased capacity, provision for which has been made in the building. The machinery was furnished by Jenckes Machine Co., Sherbrooke, Quebec, made according to designs furnished by the undersigned.

(GEORGE WILLIAMS,

Engineer of Construction,
Butte, Montana.)

Testing for Gas.

Editor Mines and Minerals:

SIR:—I have read with interest the recent articles upon testing for gas, in the April number of MINES AND MINERALS, (page 429), and in the July number, (page 570), as well as the communications of Mr. Davies in April, (page 417), and that of Mr. Mills in July, (page 551). With your kind leave I beg to differ to some extent with all of these gentlemen, and perhaps also with theory. My experience in this regard has led me to believe that the length of the flame cap alone is not a true indication of the

percentage of gas present in the mine air. I claim there is more in the make up of the cap, and its color, than in the height which it attains in the gaseous mixture, and I will try to prove this further on.

I am fire boss for the Cambria Company of Johnstown. There are three fire bosses, and our opportunities are particularly good for making observations in regard to the testing for gas. The mine in which we are employed has been opened up for a distance of three miles from east to west, and about two or three miles from north to south. It is divided into five separate sections or districts, each district having its own circulation; so that an explosion occurring in one district is not liable to affect the other districts of the mine. There are days when one or more of the districts of the mine are idle, and such occasions afford excellent opportunities for the fire bosses to experiment, either alone or in company with each other. We have devoted many such off days to experimenting upon gases; hence our experience.

Mr. Davies gives us in the April number, page 418, seven caps varying in height from $\frac{3}{4}$ " to $4\frac{3}{4}$ ". He says that the first three are not explosive, that is, the caps from $\frac{3}{4}$ " to $1\frac{1}{4}$ ". I have found that such flames or caps at times indicate a highly explosive mixture. Mr. Davies believes that the caps varying in height from $1\frac{1}{4}$ " to $4\frac{3}{4}$ " are highly explosive. I beg to differ from him here. That my friend may be correct theoretically, or even in certain mixtures of gas, I will admit, but how often do we find this in practice? I will agree with him when he asserts the first three caps are the most dangerous, for I believe the most of our explosions occur under conditions producing these flames.

Again Mr. Mills says (July, page 551), that with the normal flame he can get caps from $\frac{1}{4}$ " up to 2", and can detect smaller percentages of gas, and get better results with this normal flame. I think Mr. Mills makes a slight mistake here. I have used the safety lamp, more or less, since the year 1867, and have practiced with lamps of every shape and form, and tried to explode small quantities of gas; tried to pass flame, etc., but failed. I find the normal flame is not correct in all kinds of mixtures. In the strongest kind of mixture, I have observed that the effect is to lower the flame, if anything. In such a case the only way that I could detect the gas would be by a small flicker of the flame, such as it would make in a good current of air. In other cases the flame would not be affected, while, by using a small flame, I could get a cap fully one inch high.

We use the common Davy lamp here, and have used the following oils: First: Sperm oil, the best we could get; the results with this oil were not good. Second: A mixture of four parts of sperm oil with one part Headlight Water White, 150° test. The results with this mixture of oil were good. Third: Headlight Water White, 150° test, with Davies & Sons patent oil burner. This burner gives the most uniform light, and the best results were obtained in its use. I will give some of the caps as we found them. I examined two headings from which air was shut off by water, using a normal flame. My light spindled out to the top of the lamp. I then lowered the flame and tried again, but could not get a cap; the lamp, however, appeared to be full of a very pale blue mixture, the light burning brilliantly all the time. In this mixture we became dizzy and our eyes were heavy. I claimed it to be CO, others said it was marsh gas (CH_4), wanting oxygen. At another time experimenting, I got a cap about one inch high; I tried to raise it, but found an explosion in the lamp resulted every time, producing a deep purple color, sometimes giving off sparks. When this mixture exploded in the heading it appeared stratified, a lower stratum being a deep purple, while the upper stratum of gas was a light blue. At another time I got a nice pale blue cap about $\frac{1}{4}$ " high; I advanced, it raised; I still advanced, and it continued to raise until it filled the lamp and exploded. The question arises, What have I? I get a cap about one inch high, of a very dark blue or indigo; I try to raise my cap, but it explodes every time. This gas is very quick, so is that giving the purple cap previously mentioned. That these are different gases seems to me evident, and again I ask the question: What are these gases? Again, at another time, I get a cap about $\frac{1}{4}$ " high, of a very pale blue or gray color; I advance in it, it turns blue; I still advance, and get a cap the full height of my lamp; the center is of a purple color while the outside is pale blue. This gas also is highly explosive, and I ask, What is it? Again I get a cap the full height of the lamp, very pale blue, inclined to gray; I open my lamp, and insert it into the mixture, but it will not ignite, but forms a halo around the light. I ask, How is this? This mixture gives a cap $3\frac{1}{4}$ " or 4" in height, and will not burn. Again, I get a cap about $\frac{1}{4}$ " high, and have about 2 feet of this mixture. I insert my lamp into the mixture, and get as pretty a cap as I have ever seen; still it will not ignite. Again, I get a cap the full height of the lamp, of a very pale blue, inclining a little to gray. This mixture burns so feebly you can walk away from it. Again, I get a cap of a very, very pale color; sometimes it is hard to detect this, and the mixture will give caps from $\frac{1}{4}$ " up to the full length of

the lamp; often it refuses to ignite, and when it does it burns very feebly.

The statements just made are none too strong, and seem to prove clearly that the height of the flame cap alone is no true indication of the explosive character of the gaseous mixture. I can prove every day in the week that the $\frac{1}{4}$ " cap will explode, and that with the greatest violence; and I beg to say that we need no other occurrence than a naked light to produce ignition. A cap $\frac{1}{4}$ " high does not always represent 4 per cent. of marsh gas, by any means.

About 18 inches or 2 feet above our coal, there is the best kind of a smooth roof. It is as level as it can be made, and like glass. Against this roof the gas often lies in a thin stratum, so that you cannot get a large cap. If you fan it or brush it down upon your lamp, it explodes; if you cant your lamp over, you obtain the same result; if you move your lamp in any way, or hold it in any position, it will explode.

The statements that I have seen and read in books, follow too much on the theory of pure gas and air, and do not consider enough the mixtures such as are met with in mines, and I regret to say for some reason most fire bosses and others, follow in the same line. I have given you no percentages for the gas, in any of the caps I mentioned, for I have no means of ascertaining such percentage; neither have I given you any fine measurements of the heights of a cap, for the only scale we have here is our eyes, and this is the only scale that I have ever seen.

I hope I have not intruded on your generosity, and will say that the above facts can be proven by other parties that have witnessed them.

Yours truly,

Johnstown, Pa., September 24th, 1900. JOHN RETALLUCK.

We always regard very highly such testimony from daily practice. The opportunities afforded such men are numerous, and the fact that a man will improve such opportunities to practice and verify the results of others, and then to communicate his own results and convictions, for the good of others, shows him to be a thoughtful, painstaking man. An extended experience, covering 25 or 30 years, in the use of the safety lamp, in the detection of gas, is not to be idly set aside. It is possible for any of us to be misled, or to misinterpret results of our own investigation, however carefully our observations may be taken.

Our correspondent gives us some valuable testimony. At the same time he makes some statements which need correction; as for example, where he states that Mr. Davies said that the first three caps given by himself, including the $\frac{1}{4}$ " cap (No. 3), were not explosive. On page 417, of the April issue of MINES AND MINERALS, Mr. Davies remarks as follows: "I would say that the flames marked 1 and 2, I have not found explosive, but the flame marked 3, I believe to be explosive at certain times." This statement of Mr. Davies is in complete accord with the results obtained by Mr. Retalluck, who claims that he can prove the explosive character of the $\frac{1}{4}$ " cap obtained from a small, uniform, standard flame.

Mr. Davies rightly states that he believes all other caps above 3, are explosive caps. Our correspondent differs from this statement also. The fact of the matter is that any of these caps may or may not be explosive, in any particular case; but the statement of Mr. Davies referred to, still remains unapproachable, that the higher caps indicate explosive conditions in the mine atmosphere, and must be guarded against with extreme care and caution. This statement will not be questioned. Conditions can always exist in the character of the workings and the manner in which they are maintained, that will make the shorter caps, at times, explosive; or that will render the longer caps at times in explosive; but these conditions are conditions that are local and incident wholly to the general method of mining and ventilation practiced in any particular mine or district. The essential character of each mine gas must be studied as an element, separately and distinct by itself; as the character of each gas is always the same, as far as it is itself concerned. These are the essential elements, which every fire boss and official in charge of a gaseous mine should thoroughly understand, and upon which he should base his reasoning. There are not numerous, different gases occurring in mine workings; but they are few and simple in their character. It is true varying mixtures of these gases produce results which grade between these elementary results, and manifest numerous variations according to the predominance of one or another of the mine gases. We endeavored in a previous article, April, page 429 to make clear this modifying influence in varying mixtures of mine gases; and much that Mr. Retalluck has said in giving his own experience in testing for gases, will be found to conform with what was said in that article. The presence of fine dust suspended in the air of the mine, especially where the coal is soft and inflammable, will give rise to the production of a considerable quantity of carbonic oxide gas. This gas is also formed in the vicinity of a large area of waste or abandoned workings. The presence of carbonic oxide gas undoubtedly has the effect of

lengthening the flame cap; and renders percentages of marsh gas explosive that would not otherwise be so. Under these conditions one of the higher caps, say, 1½" or 2" cap, may result when the quantity of marsh gas is perhaps not greater than 2 or 3 per cent. The gaseous mixture, however, is highly explosive. The color of the flame will also be altered by the presence of carbonic oxide gas. The flame of pure marsh gas is particularly a non-luminous, pale blue flame. The color of this flame is somewhat deepened, and approaches a purplish or violet tinge when any considerable amount of carbonic oxide gas is present. Thus, the color of the flame furnishes somewhat of an index of the character of the gaseous mixture; and our correspondent is correct in his idea that the color of the flame indicates to a certain extent the character of gas present. The color of the flame will be altered very much not only by the percentage and kind of gas present; but by the character of the burning, and amount of available oxygen. In general the paler the flame, the purer the marsh gas or firedamp mixture; and the deeper the flame, the larger the percentage of impure gases in the firedamp mixture.

The effect of the presence of carbonic acid gas in firedamp mixtures is not only to depress the flame and shorten the cap, but to render in explosive such mixtures which would otherwise be highly explosive. These conditions may be extremely local, however; and at a point not far distant, the same current may be found ignitable and explosive, which refused to ignite at that particular point of the workings. The rapidity of the burning of any body of gas is largely an index of the strength of the air current, or the circulation at that point; the more quiet burning indicating a sluggish and deficient circulation. The amount of air present also varies very greatly the intensity of the color of any flame; the larger the amount of air present, the paler the flame.

All of these influences contribute very materially to alter the absolute color due to any percentage or kind of gas in a firedamp mixture; and render more or less uncertain the exact explosiveness of the gas in question in any particular case, except as viewed in the light of the surroundings at the particular point of the workings where the gas test is made. We should consider each test from the basis of a normal state of the mine workings; as, for example, where ventilation is ample, and but a small amount of dust is present in the mine air, and there is the absence of conditions that would yield a large amount of carbonic acid gas (blackdamp.) Every gas test should be made with these modifying conditions clearly in mind; and under no circumstances should one of the higher caps be regarded as safe or in explosive because it appears to be so at any given point of the workings. It should always be borne in mind that any explosive cap may become explosive from the slightest occurrence or change in the conditions prevalent in mine workings.

In conclusion we cannot agree with our correspondent in the setting aside of the height of the flame cap as being the better index of the explosive character of a gaseous mixture; nor with his suggestions in regard to the color of the flame as being a better index of such explosive character, in a gaseous mixture. All of these evidences have their value and bearing; but the height of the flame cap is certainly a more essential element, and will undoubtedly continue to be regarded as a safe index of the explosive character of firedamp mixtures when safeguarded by a broad judgment and intelligent understanding of the influence of other mine gases when present in firedamp mixtures.

Wire Ropes for Transmission of Power.

A recent correspondent writing in reference to the article "Rope Transmission In Mine Haulage," Page 89, MINES AND MINERALS, September, 1900, after commending the article very highly for its practical value, makes some interesting references to the rules in English practice for determining the minimum diameter of sheave, drum, or pulley which can be used for any size rope without injury to the rope. Our correspondent quotes from no less than three of the largest rope manufacturers in Great Britain, and we regard these quotations of so much interest as setting forth clearly the difference between English and American practice in this respect, that we give them below just as they have come to us.

"I am sending you rules by R. S. Newall (the oldest rope maker in Great Britain) for the minimum sizes of pulleys for ropes of given size and make:

Size of Drums or Pulleys.—To determine the minimum diameter of drums or pulleys around which six strand wire ropes may be worked, the following rules will be found useful.

Ascertain the number of wires which form the outside course of one strand. When the cores of the strands are also of wire these are not to be counted, only the outside wires. For 6 wires, square the circumference of the rope and multiply by 8; for 9 wires square the circumference of the rope and multiply by 5; for 12 wires square the circumference of the rope and multiply by 2; for 15 wires, square the circumference of the rope and multiply

by 1.75; for 18 wires square the circumference of the rope and multiply by 1.50; for 21 wires square the circumference of the rope and multiply by 1.25; for 24 wires square the circumference only. The result in each case gives the necessary or minimum diameter of drum or pulley in inches. Larger diameters than these should be adopted when practicable.

When the rope is worked at a high speed, as in shaft winding, power transmission, etc., these rules do not apply. The following should then be used:

Wire Rope Transmission of Power.—For 6 strand 7 wire ropes, pulleys should be 150 times the diameter of the rope; for 6 strand 9 wire ropes, pulleys should be 115 times the diameter of the rope; for 6 strand 19 wire ropes, pulleys should be 90 times the diameter of the rope.

"The White Cross Co., Ltd., who are large manufacturers of ropes and large colliery owners in England, say:

"There is no rule, so far as we know, by which the bending stress of a certain load over pulleys of a given size can be calculated. The fact is, that in this matter, an ounce of experience is worth a ton of theory."

"Geo. Craddock & Company write:

"There is no rule for the respective sizes of ropes and pulleys. It is purely a matter of experience, and how ropes have worked under similar conditions in other places."

These rules or methods of dealing with an important subject are unsatisfactory to say the least. Rope consumption forms one of the most expensive factors in mine haulage, and to say that there is no specific or general rule for determining the sizes of sheaves to be used with different sizes and makes of ropes, and that this can only be determined by experience, places the consumer very largely in the hands and at the mercy of the manufacturer. It is then the judgment and experience of the latter that must dictate the sizes of drums, pulleys, and sheaves for particular ropes. It is his judgment that will arbitrarily say when the life of a rope has proven too short, that this is the result of the use of too small a sheave, and the consumer must abide by his judgment. The general rule that represents very closely American practice in this regard, is that given upon page 91 of the article referred to above, and may be stated as follows:

For steel wire ropes of 6 strands: (7 wires per strand), minimum diameter of sheave is 80 times the diameter of the rope, (12 wires per strand), minimum diameter of sheave is 60 times the diameter of the rope, (19 wires per strand), minimum diameter of sheave is 50 times the diameter of the rope. In the use of iron ropes these ratios are doubled.

It will be observed that there is a vast difference between these general rules of American practice, and the rules stated above as employed in England. This difference consists not merely in the value of a numerical constant, but exhibits a different law of variation, in the two cases; American practice making the diameter of the sheave a multiple of the diameter of the rope, while the English practice, as quoted above, makes the diameter of the sheave a multiple of the square of the circumference, or the square of the diameter of the rope.

The question of determining the bending stress to which the outer fibres of a rope are subjected when passing over a sheave of a given diameter, has received at the hands of scientists a very beautiful theoretical investigation. Theory has thus demonstrated that the bending stress is in proportion to the ratio existing between the diameter of the outer wire of the rope and the diameter corresponding to the curvature of the rope. The expression for this bending stress has been given as follows:

$$\text{Bending stress} = E \frac{d}{D}$$

Where E = modulus of elasticity (steel 26,000,000 to 32,000,000, iron 25,000,000 to 26,000,000),
 d = diameter of single, outer wire of the rope (inches),
 D = diameter corresponding to the curvature of the rope (inches).

It has been further demonstrated, and this important fact has been taken into consideration by American manufacturers, that the radius of curvature which a rope will assume when bending around a sheave, depends upon three factors. (1) The tension or load upon the rope. (2) The angle of deflection or angle of bending. (3) The rigidity of the rope. Regard for these facts has led to the knowledge of a very important factor or element in rope installation, which rope manufacturers cannot afford to ignore however contemptuously they may speak of a theoretical investigation. It is this same theoretical investigation given the subject by our American manufacturers, that has revealed the fact that for a small angle of deflection in the rope, or for a light load upon the rope the radius of the sheave can be much less than the radius of the curvature assumed by the rope, without injury to the rope.

All machine design and the solution of all mechanical problems are today effected along the lines of theoretical investigation. Valuable as practical judgment is, it still remains a fact that this alone would make bungling work out of many of the most important mechanical problems which arise in machine practice. We do not deny that theoretical considerations assume conditions that are rarely realized in practice in their entirety. It is not claimed that theory can express exactly the values of loads and stresses under all the varying conditions of practice; but that certain specific, exact results and values are obtained that furnish a sure and safe guide invaluable to practice. Any practical man who has had a previous technical training will not attempt to deny the value of the exactness of theoretical investigation, and an attempt upon the part of manufacturers to ignore these principles can only result in disaster to themselves, as such a course leads only to confusion and the dwarfing of the advance of science.

Cost of Mine Haulage.

In reply to an inquiry asking for the cost of electrical mine haulage addressed to the electrical engineer of one of the largest coal companies in Western Pennsylvania, the following reply was received:

"In reply to yours, regarding cost of mine haulage, would say that I am not able to give you costs of the purely electrical part of the haulage, since we do not separate this from the total cost from rooms to tippie. This total cost, I find, depends so much upon local conditions (and which have no connection with the electrical part of the haulage), that we can get no reliable data on the cost of delivering coal from main parting to tippie with electric motors. The cost for a single month at twenty mines using electric haulage, was .063 per ton of run-of-mine coal. The average output per mine was 18,200 tons. In thirty-one mines using rope haulage for the same month, the cost was .0765 per ton; average output, 13,200 tons each. In twenty-one mines using mule haulage, the cost was .0604 per ton; average output, 8,500 tons."

Examinations in Iowa.

A recent letter from Iowa states that an examination of mine foremen and hoisting engineers was held at Boone, beginning October 1st and lasting four days. This is the fifth examination that has been held by the Examining Board for this purpose. Two more examinations are expected to be held this year as follows: At Des Moines beginning November 12th, and at Ottumwa beginning December 17th.

The Board of Examiners, as we have previously announced, consists of Floyd Davis, President, Des Moines; James E. Stout, Secretary, Des Moines; Alex. Dargavell, Centerville; John Owens, Beacon; J. W. Lewis, Hiteam. These gentlemen deserve much credit for the manner in which they have taken up and prosecuted the work of examination of so large a number of mine foremen and hoisting engineers. Between four and five hundred men have been granted certificates. Of these nearly one-half were time certificates as provided by law, for a term of service of four years immediately preceding the date when the law takes effect, January 1st, 1901. Few have failed in the examinations, which have been conducted on a broad, practical basis.

Personals.

The Lookout Mountain Coal & Coke Co., with mines at Durham, Ga., has applied for a charter under the laws of Georgia with Mr. George P. Howard, of Atlanta, President; Alvin J. Howard, Secretary and Treasurer; A. W. Evans, Superintendent and Engineer. The property is adjacent to that of the Durham Coal & Coke Co., described in a recent issue of MINES AND MINERALS and the famous Durham coal will be mined, the first car having been shipped September 13th.

F. H. Daniels, of Worcester, Mass., chief engineer of the American Steel & Wire Co., has been especially honored in the Paris Exposition, receiving a gold medal in recognition of the valuable services he has rendered in bringing to a high standard the art of wire drawing and rod rolling; also for attaining a superior degree of excellence in the manufacture of wire goods from wire, and especially for perfecting the Daniels system of copper rail bonds, now in use all over the world. Mr. Daniels had entire charge of preparing the exhibit of the American Steel & Wire Co., and this company has also been awarded a grand prize for major metallurgy, and also a grand prize for minor metallurgy, receiving besides a gold medal for rail bonds, music wires, and other wire products.

W. A. Cornelius, superintendent of the 10-, 23-, and 30-inch mills of the Carnegie works at Homestead, Pa., resigned recently to become superintendent of the operating departments of the National Tube Co.'s works at McKeesport, Pa. D. S. Kennedy succeeds Mr. Cornelius at Homestead.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for November.

QUES. 628.—*Efficiency of a Pump.*—Determine the efficiency of a pump that is discharging 1,200 gallons of water per minute, under a vertical head of 250 feet, at an expenditure of 125 horse-power. What should be the diameters of the discharge and suction pipes respectively of this pump?

QUES. 629.—*Relative Diameters of Steam and Water Cylinders in Pumps.*—Determine the relative diameters of the steam and water cylinders of a direct acting pump when the vertical lift is 300 feet, the steam pressure at the bottom being 75 pounds per square inch.

QUES. 630.—*Cause of a Shot's Hanging Fire.*—Explain the conditions which may cause a shot to hang fire, in both fuse and electric blasting. In electric blasting is it possible for a shot to explode after the wires have been disconnected and the battery taken away?

QUES. 631.—*Pumping With Compressed Air.*—A direct acting mine pump located at a distance of 500 yards inbye from the bottom of a shaft 300 yards deep, is operated by compressed air. The air is conducted from the surface down the shaft and to the pump, through a pipe 3 inches in diameter. The diameter of the air cylinder of the pump is 10 inches and the piston speed 100 feet per minute. The pump discharges at the top of the shaft, under a head of 1,000 feet. Assuming that the temperature of the compressed air at the surface is 80° F., its temperature at the pump 60° F., and the gauge pressure at the surface 90 pounds, (a) determine the gauge pressure at the pump when the pump is not running. (b) Determine the gauge pressure at the pump when the latter is in operation. (c) Determine the diameter of the plunger of this pump and its discharge in gallons per minute.

QUES. 632.—*Safety Lamps With Copper Gauze.*—State the advantages and disadvantages arising from the use of copper gauze in safety lamps.

QUES. 633.—*Driving Roadways.*—State the manner in which you would drive a main roadway in a seam of coal 4 feet thick, the height of the roadway to be 5 feet in the clear above the rail. The floor of the seam is an underlay that heaves readily. Above the coal is a draw-slate varying from 18 inches to 2 feet in thickness overlaid with a hard slate.

QUES. 634.—*Method of Working an Inclined Seam of Coal.*—Describe in detail the manner in which you would open a breast in a seam of coal pitching 10°. The strike of the seam is N 60° W or S 60° E. The gangways or levels are driven so as to provide drainage toward the shaft. The face cleats of the coal are free and the coal is best worked "longhorn." Give the width of room and room pillars, and the direction in which the rooms should be driven. The general thickness of cover is 250 feet, the coal is a good quality. The roof slate is 18 feet in thickness, and strong, the floor is a hard fireclay.

QUES. 635.—*Bending Stress in a Wire Rope Passing Over a Sheave.*—Calculate the bending stress (lbs. per sq. in.) in the outer fibers of

a 1½" steel wire rope having 6 strands of 7 wires each, when passing over a sheave 9 feet in diameter. If the actual net load upon this rope is 5 tons, what is the factor of safety in the rope?

Answers to Questions Which Appeared in the September and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 602.—Percentage of Gas in a Ventilating Current.—The ventilating current in a certain district of a mine is charged with gas to the amount of 3 per cent., as shown by the Shaw gas-testing machine. The ventilating pressure in this mine gives a water gauge of 2½ inches. A fall upon the main intake has so reduced the volume of the air current that the water gauge reads only 1 inch. Determine the percentage of gas in this current.

Ans.—Assuming the volume of the return current to be 10,000 cubic feet; then, three per cent. of this quantity being gas, $10,000 \times .03 = 300$ cubic feet is the quantity of gas given off each minute, and the quantity of pure air which enters the district each minute equals $10,000 - 300 = 9,700$ cubic feet. Now this volume of air will vary as the square root of the pressure varies; hence

$$\sqrt{2.25} : \sqrt{1} :: 9,700 : x; \text{ and } x = \sqrt{\frac{1}{2.25}} \times 9,700 = 6,466 + \text{cu. ft.}$$

That is to say with one inch of water gauge, we will have 6,466 + cubic feet of air in circulation. The transpiration of gas increases as the [absolute] pressure decreases; but [the change in absolute pressure being small] the volume of gas, in this case, will not be appreciably affected, and the percentage of gas now in the current equals $\frac{300 \times 100}{6,466 + 300} = 4.44$ per cent., nearly.

JAMES RADFORD, Springfield, Ill.
Second Prize.—D. P. BROWN, Coalbrook, Penna.

QUES. 603.—Ventilation of Dip and Rise Workings.—An inclined seam is worked both to the rise and dip from the bottom of the shaft. The inclination of the seam is 35°. The length of the main incline to the rise is 400 yards, while the dip has a length of 300 yards. The average temperature of the intake airway to the rise is 45° and to the dip 50°; while the temperatures of the return currents, after traversing the gangways of the rise and dip workings are 60° F. and 70° F., respectively. The ventilation in this mine is produced by a fan which is circulating a current of 80,000 cubic feet per minute; 50,000 cubic feet going to the rise workings and 30,000 to the dip workings. The water gauge at the foot of the shaft is 1.5 inches. Owing to an accident the speed of the fan has been reduced and the water gauge has fallen to .5 inch. Determine the quantity of air that will be in circulation under these conditions in both the rise and dip workings.

Ans.—The vertical height of rise incline is $400 \times 3 \times \sin 35^\circ = 400 \times 3 \times .57358 = 688$ ft.; and the vertical depth of dip incline is $300 \times 3 \times .57358 = 516$ ft. The motive column in main intake [water being 816 times as heavy as air] is $\frac{816 \times 1.5}{12} = 102$ ft. The [natural] motive column in the rise incline is $\frac{688 \times 60 - 45}{459 + 45} = 20.48$ ft., and the [natural] motive column in

the dip incline is $516 \times \frac{70 - 50}{459 + 50} = 20.28$ ft. As this motive column in the rise workings acts to retard the ventilation, the effective motive column in the rise incline is $102 - 20.48 = 81.52$ ft.; and likewise as the motive column in the dip workings assists the ventilation, the effective motive column in the dip incline is $102 + 20.28 = 122.28$ ft.

When the water gauge reading at the foot of the shaft falls from 1.5 inches to .5 inch the main intake air column is decreased from 102 feet to $\frac{816 \times .5}{12} = 34$ ft.; the effective air column in

the rise workings is then decreased to $34 - 20.48 = 13.52$ ft.; and the effective air column in the dip workings is $34 + 20.28 = 54.28$ ft. Now since the quantity of air in circulation in any airway varies as the square root of the pressure or air column, we have for the quantity of air passing in the rise workings after the decrease in the water-gauge occurred, $\sqrt{81.52} : \sqrt{13.52}$

$$:: 50,000 : x; \text{ and } x = \sqrt{\frac{13.52}{81.52}} \times 50,000 = 20,362 \text{ cu. ft. In the}$$

dip workings, we have, $\sqrt{\frac{54.28}{122.28}} \times 30,000 = 19,988 \text{ cu. ft.}$
M. FAGAN, Pana, Ills.

Second Prize.—ADOLPHE COOK, Cokeville, Pa.

[The above solution is approximate, since it compares motive columns or air columns of different temperatures, and therefore different densities. It will be observed that the motive columns, as obtained above, are referred to the temperature of the return air, in each case; the formula used being

$$M = D \times \frac{T - t}{459 + t}$$

(see P. C. Ques. 546, page 316, MINES AND MINERALS, February, 1900). To obtain the motive column for the main intake it is assumed that water is 816 times as heavy as air. This is true only when the temperature of the air is 60° F. (bar. 30"). This is a general, approximate method of converting water gauge into air column. The motive columns for the main intake air, thus obtained are, before the accident occurred 102 feet, after the accident 34 feet. These air columns are each for air having a temperature of 60° (bar. 30"). The air column due to the rise (20.48 ft.) has a temperature of 60° F., while the air column due to the dip (20.28 ft.) has a temperature of 70° F. It is not strictly accurate to add and subtract these air columns and the air column obtained for the main intake, except in the first case, for the rise workings, since they are not of the same density.

The solution presented by Mr. Cook was based upon the water-gauge reading; while Mr. John Fyfe, Windber, Pa., and others gave solutions based upon the pressure per square foot. All of these solutions would have had precedence over the solution of Mr. Fagan given above, had they not contained numerical errors, which caused the latter approximate solution to give the closest results. We give below the outline of Mr. Cook's solution, corrected. The method of solution by means of motive columns although a very general method, is one that is often used in such calculations; hence, it would not be considered wrong. At the same time it is liable often times to give results which vary considerably from the truth. There are many of these general methods of calculation in use in mine practice, but they should be avoided wherever it is possible.—EDITOR.]

Rise Workings.—

$$\begin{aligned} 400 \times 3 \times .57358 &= 688 + \text{ft., vertical rise.} \\ 60 - 45 &\times 688 = 19.88 \text{ ft., air column (temp. } 45^\circ \text{ F.)} \\ 459 + 60 &\times 19.88 \\ 1.3253 \times 30 &= .302 \text{ in., water gauge due to rise.} \\ 459 + 45 &\times 5.2 \\ \sqrt{\frac{.5 - .302}{1.5 - .302}} \times 50,000 &= 20,327 \text{ cu. ft.} \end{aligned}$$

Dip Workings.—

$$\begin{aligned} 300 \times 3 \times .57358 &= 516 + \text{ft. vertical fall.} \\ 70 - 50 &\times 516 = 19.51 \text{ ft. air column (temp. } 50^\circ \text{ F.)} \\ 459 + 70 &\times 19.51 \\ 1.3253 \times 30 &= .293 \text{ in., water gauge due to dip.} \\ 459 + 50 &\times 5.2 \\ \sqrt{\frac{.5 + .293}{1.5 + .293}} \times 30,000 &= 19,951 \text{ cu. ft.} \end{aligned}$$

QUES. 612.—Haulage, Load Upon Guide Sheaves.—Calculate the load upon the journals of each guide sheave around a curve in a haulage road. The radius of the curve at the center line of track is 48 feet, and the sheaves are set 26 inches from track center, and 4 feet apart, center to center. The tension upon the rope is 6 tons.

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—THEODORE SIMONS, Roseland, B. C.

[Award was made as given above on Ques. 612, but owing to a delay in getting out we are obliged to hold the answer till the December number.—EDITOR.]

QUES. 613.—Timbering, Size of Collar.—In the timbering of the airways of a certain mine, if we use round timber and the depth or diameter of the collars is 8 inches in an airway 8 feet wide, what should be the depth of the collars when the width of the airway is 14 feet?

Ans.—The load round timber will support varies as the cube of the diameter of the timber, and inversely as the length between the supports. The distance between the supports of a collar beam is rarely equal to the width of the entry; but in solving this problem we will assume such to be the case. Denoting the diameter and length of the 8-foot collar by d_1 and l_1 , respectively; and of the 14-foot collar by d_2 and l_2 , we have [since the entire load (wl) supported by the beam varies, for round timber, as the cube of the diameter (d), and inversely as the length (l); or wl varies as $\frac{d^3}{l}$,

and w varies as $\frac{d^3}{l}$; and since the unit weight (w), or the weight on a unit of length of the collar is the same for each collar $\frac{d_1^3}{l_1^2} = \frac{d_2^3}{l_2^2}$; or] $d_2 = d_1 \sqrt[3]{\left(\frac{l_2}{l_1}\right)^2}$. Substituting the given values in this formula we have for the diameter of the 14-foot collar $d_2 = 8 \sqrt[3]{\left(\frac{14}{8}\right)^2} = 11.6$ in.

Or we may reason as follows and obtain the same answer: If an 8-foot collar will support a load of 1 ton, a 14-foot collar of the same diameter will support $\frac{8}{14}$ ton; but under the conditions the

longer collar is required to support $\frac{14}{8}$ ton, [to do which its diameter must be $\frac{14}{8} \div \frac{8}{14} = \left(\frac{14}{8}\right)^2$]. But, since the load a collar will support varies as the cube of the diameter, the diameter of a collar to support a given load varies as the cube root of the load. Hence, in this case, $\sqrt[3]{1} : \sqrt[3]{\left(\frac{14}{8}\right)^2} :: 8 : x$, and the diameter of the 14-foot collar will be $8\sqrt[3]{\left(\frac{14}{8}\right)^2} = 11.6$ in.

JAMES RADFORD, Springfield, Ills.

Second Prize.—J. EDWARD MILLIS, Belle Vernon, Penna.

QUES. 614.—*Timbering, Relation of Diameter to Length of Post.* How should the diameter of prop timber vary with respect to the length of the prop or thickness of the seam? In timbering a certain mine, if 5-foot props are used in the rooms, and these props have a minimum diameter of 6 inches, what should be the minimum diameter for posts set upon the roads in this mine, when the roadway props have a length of 8 feet?

Ans.—The diameter of prop timber (posts) varies [approximately] as the cube root of the length of the post. Hence when using 5-foot room timber, having a minimum diameter of 6 inches, the diameter of 8-foot road props should not be less than $6\sqrt[3]{\frac{8}{5}} =$ say 7 in.

WM. PILKINGTON, Osceola Mills, Penna.

Second Prize.—D. P. BROWN, Coalbrook, Penna.

[We fear from a large number of replies to this question, the rule, in common use, relating to beams (collars) has been interpreted as applying also to post timber. In the latter case there is no law that expresses exactly the relation between the diameter and length of a post supporting a load of compression. Approximately, the diameter varies as the cube root of the length of the post for the same total load on the post, as stated above.—EDITOR.]

QUES. 615.—*Hoisting, Size of Engine.*—Calculate the size of a duplex second-motion engine geared 1 to 3, the ratio of length of stroke to diameter of cylinder being 1.25, that will hoist a maximum output of 1,000 tons per day, from a double compartment shaft 800 feet deep. The weight of the cages is 2,200 pounds each and the weight and capacity of mine cars is 1,400 pounds and 2,000 pounds, respectively. The length of a working day is 8 hours. Allow $\frac{1}{6}$ of the total moving load for friction, and estimate upon the engine as having an efficiency of 60%; the engine to cut off at $\frac{3}{4}$ stroke, the boiler pressure being 90 pounds per square inch. No balance rope is used beneath the cages.

Ans.—On account of the depth of this shaft (800 ft.) and the comparatively light cars (capacity 2,000 lb.) indicating a seam not exceeding 4 or 5 feet in thickness we will assume two cars are hoisted at a time.

The number of hoists per hour will be $\frac{1,000 \times 2,000}{2 \times 2,000 \times 8} = 62.5$ hoists. Allowing 30 seconds for caging cars, the actual time of each hoist will be $\frac{(60 \times 60) - (62.5 \times 30)}{62.5} = 27.6$ sec., and the speed of winding will be $\frac{800}{27.6} =$ say 29 ft. per sec., or 1,740 ft. per min.

Assuming a $1\frac{1}{2}$ inch plough-steel rope, weighing 2 pounds per lineal foot, the ascending load on the rope will be $2 \times 800 + 2,200 + 2(1,400 + 2,000) = 10,600$ lb. = 5.3 tons. The breaking load of a $1\frac{1}{2}$ inch plough-steel rope is 60 tons, which gives a factor of safety for this load after doubling the actual load to provide for shocks, $\frac{60}{2 \times 5.3} = 5.66$, thus giving ample security.

The total moving load is $10,600 + 2,200 + 2 \times 1,400 = 15,600$ lb., and the friction of the system will be $\frac{1}{6} \times 15,600 = 1,560$ lb. The unbalanced load is $10,600 - 1,560 = 9,040$ lb., and the load on the engine will be $9,040 + 1,560 = 10,600$ lb. The required effective horsepower of each cylinder is therefore $\frac{10,600 \times 1,740}{33,000} =$ say, 378 h. p. The efficiency of the engine being 60%, the total horsepower required of each cylinder, for this hoist will be $\frac{378}{.60} = 630$ h. p.

The gauge or boiler pressure being 90 pounds, and steam being cut off at $\frac{3}{4}$ of the stroke, the mean effective pressure in the cylinder is found by the formula M. E. P. = $.9[c(p + 14.7) - 17]$, in which p is the boiler or gauge pressure, and c a constant. (See table, page 379, MINES AND MINERALS, March, 1900). Substituting values, M. E. P. = $.9[.917(90 + 14.7) - 17] = 71.11$ lb.

Assuming that the engine makes 400 strokes per minute, the number of revolutions of the drum, in the same time, will be

$\frac{400}{3 \times 2} = 66\frac{2}{3}$, and the diameter of the drum will be $\frac{1,740 \times 3}{200 \times 3.1416} = 8.3$, say 8' 4". The diameter of the cylinder will be

$$\sqrt[3]{\frac{630 \times 33,000 \times 12}{7854 \times 71.11 \times 1.25 \times 400}} = 20.75,$$

and the length of the stroke = $20.75 \times 1.25 = 25.94$ in.; size of engine, say 21" $\times$ 26".

EVAN C. DAVIES, Duryea, Pa.

Second Prize.—CHAS. E. BOWRON, Birmingham, Ala.

QUES. 616.—*Tail-Rope Haulage.*—The haulage in a certain mine is to be accomplished by the tail-rope system. The distance from the tail sheave to the shaft bottom is 1,500 yards, and the shaft is 350 yards in depth, the engine being located upon the surface at the mouth of the shaft. The seam is generally flat, but there are up and down grades in the haulage road, the steepest being a 10%-grade in favor of the empties. Calculate the size of rope and the effective horsepower required from this haulage, assuming an output of 900 tons in 10 hours, the weight and capacity of the mine cars being 1,200 and 1,800 pounds respectively.

Ans.—We will suppose that the tail rope is carried on the surface to a point above the tail sheave, and thence down a bore hole into the mine; also that the main and tail ropes are of the same size. Assuming a speed of winding of 12 miles per hour, or 1,056 feet per minute, the actual running time of a round trip will be $\frac{1,500 \times 3}{1,056} \times 2 = 8.52$ minutes, and supposing 2 minutes

are required for changing ropes at the shaft bottom and inside parting, each, the total time consumed in making a round trip will be $2 + 2 + 8.52 = 12.52$, say 12.5 minutes. The total number of cars handled per day will be $\frac{900 \times 2,000}{1,800} = 1,000$. The

number of trips per day will be $\frac{10 \times 60}{12.5} = 48$; and the number of cars in each trip will then be $\frac{1,000}{48} = 20.83$, say 21 cars. The

seam being generally flat the greatest pull on the rope will occur when the loaded trip is ascending the 10% grade, since this grade rises towards the shaft; and we calculate for this maximum pull on the haulage rope.

Let T = pull on rope (lb.);
 W = weight of loaded trip (lb.);
 w = weight of rope per lineal foot (lb.);
 l = length of both ropes; equals twice the distance from drum to tail sheave (ft.);
 d = vertical drop of rope in shaft (ft.);
 a = slope angle of maximum grade.

A grade of 10% is equal to a pitch of $5^\circ 43'$. Assuming a $\frac{1}{2}$ -inch plough-steel rope, having 6 strands of 7 wires each, and weighing 1.12 pounds per lineal foot, the gravity pull of the rope will be the pull of that portion of it that hangs vertically in the shaft, since the gravity pulls of the main rope upon the several up and down grades of a flat seam will balance each other. Then, for the tension upon the main rope, at the winding drum, we have,

$T = W\left(\sin a + \frac{\cos a}{40}\right) + w\left(d + \frac{l}{40}\right)$. Substituting given values,
 $T = 21(1,200 + 1,800) \times \left(.0996 + \frac{.995}{40}\right) + 1.12\left(350 \times 3 + \frac{1,500 \times 3 \times 2}{40}\right) =$ say 9,270 lb., or 4,635 tons; giving a factor of

safety of $\frac{33}{4.635} =$ say 7, since the breaking strain of this rope is 33 tons.

The effective horsepower of the winding will be $\frac{9,270 \times 1,056}{33,000} = 296.64$ h. p.

EVAN C. DAVIES, Duryea, Pa.

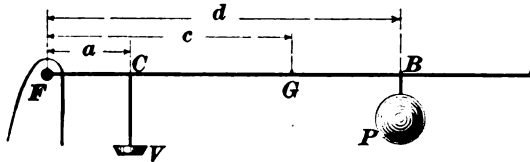
Second Prize.—CHAS. E. BOWRON, Birmingham, Ala.

[In the above answer, the fact has been overlooked that since the tail rope is conducted over the surface, and descends into the mine through a bore hole at the tail sheave, its weight in descending is subtractive from the friction pull of the tail rope on the rear end of the trip. Since, in this case, this descending weight exceeds the friction pull of the tail rope, the latter should not be considered. This would reduce the tension or load upon the main rope 126 pounds, giving for this load $9,270 - 126 = 9,144$ lb.—EDITOR.]

QUES. 617.—*Safety Valve.*—The distance from the fulcrum to the stem of a safety valve is 5 inches, the diameter of the valve seat $2\frac{1}{2}$ inches, the weight of the lever 15 pounds, and its center of gravity 10 inches from the fulcrum. If the ball weighs 75 pounds, how far should it be set from the fulcrum, in order that the valve will blow off at a boiler pressure of 90 pounds per square inch?

Ans.—Since the valve is 2.5 inches in diameter and the

required boiler pressure 90 pounds per square inch, the total pressure on the valve, at the moment preceding the blowing off, is $.7854 \times 2.5^2 \times 90 = 441.7875$ lb. To balance this upward pressure acting with a leverage of 5 inches, we have a weight of 15 pounds (weight of lever) acting with a leverage of 10 inches, and a weight of 75 pounds (weight of ball) acting with a leverage



of x inches. Since these opposing forces are in equilibrium, their moments are equal, and we have $75x = 441.7875 \times 5 - 15 \times 10$; whence $x = 27.4525$ inches.

[The moment of the force acting to raise the valve, must equal the sum of the moments of all the forces acting to depress the valve; or expressed as a formula (See Fig.) if W and W_1 are the weights of the ball and lever, respectively; and P the total steam pressure on the valve V , the center of gravity of the lever being at G , we have, $Pa = Wd + W_1c$.]

C. D. WRAY, Lillooet, B. C., Can.

Second Prize.—CHAS. E. BOWRON, Birmingham, Ala.

QUES. 618.—*Energy of Fly Wheel*.—The fly wheel of an engine measures 6 feet in diameter, out to out, and 8 inches on the face, the thickness of the rim being 3 inches. If this wheel is set upon the crank shaft of a $12'' \times 16''$ engine, at what speed will the stored energy of the wheel equal the power of the engine, assuming a mean effective cylinder pressure of 50 pounds per square inch?

[This interesting and practical question still remains open, and we hope it will receive the attention it deserves. All of the answers received were wide of the mark.—EDITOR.]

QUES. 619.—*Ventilation, Splitting Air Currents, Power Constant*. The ventilation of a certain mine is accomplished by means of a fan running at a speed of 150 revolutions per minute. The maximum power of the engine is being employed, but the quantity of the air in circulation is not sufficient to meet the requirements. If it were possible, in this mine, to divide the ventilating current into two equal splits, still retaining the same power of the ventilator, would the quantity of air in circulation be doubled by this means? If you say No, please explain why.

ANS.—Assuming the mine in question to be reached through a deep shaft or a long slope, or to have any long main intake airway before arriving at the point where the air is divided, the providing of two equal splits (power remaining the same), while materially increasing the volume of the air, will not double the quantity of the circulation. The reason for this lies in the fact that in order to double the quantity of air circulating in a mine, by dividing it into two equal splits, we must maintain the same effective power in the mine. But an increase of power will be required in the shafts or main airways where the current is not divided; and this we cannot do.

By splitting the current we have changed the conditions in the mine; but the conditions as to depth, size and rubbing surface of the shafts or main airways remain the same as before. The passing of an increased volume of air through the shafts or main airways of a mine can only be accomplished by increasing the power formerly available in such shafts or main airways. Under the conditions of the question, such increase of power can only come from the power effective in the mine, and this fact makes it impossible to double the quantity of air in circulation by the method named. [The same reasoning applies to the passage of the increased quantity of air through the fan. This can only be accomplished by an increase of power, at the expense of the circulation, which is therefore, not doubled by splitting.]

JOHN VERNER, Oskaloosa, Iowa.

Second Prize.—J. EDWARD MILLS, Belle Vernon, Penna.

Ventilating Two Mines As One.

The following was received sometime since in criticism of the answer to Prize Contest, Question No. 522, published in MINES AND MINERALS, page 173, November, 1899.

I will not presume to enter this in the contest since the allotted time has expired. I hope, however, that if there is any error in Mr. Eicher's answer it will be rectified or that I may be enlightened and set right. What could Mr. Eicher mean where he says, "without changing the above named conditions," when it is the change that we were called to contemplate? If in any particular mine having a circulation of 20,000 cubic feet of air, the power be doubled there will undoubtedly result about 25,000 cubic feet, due to this increase of power; but what of that additional mine?

I desire to learn how the answer of Mr. Eicher can be correct,

in the present case. I give below the method I should employ in the solution of the example.

QUES. 522.—Our mine is ventilated by a furnace; the mine adjoining us is ventilated by a fan. The workings are approaching each other very rapidly and it is proposed, when the workings come together, that we shall throw the circulation of the two mines into one. Practically 20,000 cubic feet per minute is the present circulation of each mine, and it is argued that by throwing them together and allowing both furnace and fan to work upon the airways we will have in circulation double this amount of air, or 40,000 cubic feet of air passing. Please give me your opinion in regard to this.

When the workings will be joined, it is proposed to throw the circulation into one (one circulation, not one mine). The furnace, at least, marks the outlet. If the volume varies as the cube root of the power and inversely as the square root of the rubbing surface, and supposing the airways to be equal in area; then, for the power, we have $1 + 1 = 2$ and $\sqrt[3]{2} = 1.25$, and likewise for the rubbing surface of the two mines, $1 + 1 = 2$, and $\sqrt[3]{2} = 1.44$; then, $1.44 : 1.25 :: 20,000 : 17,361$ cu. ft. The loss is due to the increased friction, or high velocity.

W. H. McCLEARY, Pennsville, Pa.

[In Ques. 522 the ventilation of each mine is accomplished in a single split or air current. These separate circulations are to be thrown into one circulation as soon as the mine workings come together. Our correspondent rightly assumes that the power producing the combined circulation will be double the power of either fan or furnace, since the fan and furnace (assumed of equal power) are both working upon the same current. It is wrong, however, to assume, in this case, that the quantity varies inversely as the square root of the rubbing surface. This is only true when the pressure remains constant, which is not the case here.]

There are in reality two cases which we may consider in the solution of this example. (1) When the workings come together the air current may be conducted from the inlet of one mine to the outlet of the other mine, or from the fan to the furnace (which furnishes the upcast) in a single current, and we understand that Mr. Eicher's words "without changing the above named conditions," refer to the conducting of the new current in a single split after the connection is made, as was previously done in each mine. (2) When the connection is made the current may be conducted from the inlet of one mine to the outlet of the other mine in two splits or airways. Mr. Eicher's answer considers the first case where the ventilation, after the connection is made, is accomplished by a single current, the same as before in each separate mine. In this case, the circulation of one mine (20,000 cu. ft.) is the original quantity. After the connection is made the power is double the original power applied to this circulation, the rubbing surface and the area remaining unchanged; that is to say, the rubbing surface of one single airway, from inlet to outlet of the two mines, is practically the same as the rubbing surface of the original airways, intake and return, in one mine, and the area likewise. The formula expressing the work in terms of the quantity and of the mine is, $u = \frac{k s q^2}{a^3}$; whence by transposition we obtain, dropping the constant k and extracting the cube

root, q varies as the expression, $a \sqrt[3]{u}$. Or since a and s remain unchanged and the power is double the original power in this case, q varies as $\sqrt[3]{2}$; or, $q_1 : q_2 :: \sqrt[3]{1} : \sqrt[3]{2}$, or $20,000 : x :: 1 : \sqrt[3]{2}$, and $x = 20,000 \times \sqrt[3]{2} = 25,198 +$ cu. ft.

In the second case where the air is made to travel in two separate splits from the inlet of one mine to the outlet of the other mine, the power, rubbing surface, and area are all doubled, and we have $20,000 : x :: 1 : 2 \sqrt[3]{2}$, and $x = 20,000 \times 2 = 40,000$ cu. ft.

These are the only two cases which we have a right to consider. In every case the quantity of air in circulation will vary as the expression $a \sqrt[3]{u}$. In no case could the answer obtained by our correspondent (17,361 cu. ft.) be correct.

We are glad at any time when a short discussion of one of these answers will throw any new light upon the subject, to have any of our correspondents write us in regard to the same. In this connection, we might mention, however, that a correspondent recently wrote us in regard to the answer to question No. 573, in which the depth of a shaft was calculated from the observed time required for a stone to drop to the bottom of the shaft and the sound to return to the top. The total observed time was 10 seconds, and this correspondent calculates the distance the stone will fall in this total time, which is obviously wrong, since the 10 seconds includes also, the time required for the sound to return to the top of the shaft.

The same correspondent questions also the velocity of sound in dry air at 60° F., given in answer to the question as 1,125 feet per second, and states that this velocity, according to Herschel, is given as 1,089 feet per second at 32° F. The velocity of sound, as determined by the theoretical calculations of Prof. Rankine (Phil. Trans., 1870), is 1,090 feet per second at a temperature of 32° F. The experimental determination of the velocity of sound according to numerous experiments made at different times and in different countries, gives a velocity of 1,091.7 feet per second in one case; 1,090.6 feet per second in another case, and 1,092.8 feet per second in a third case, with a temperature of 32° F. in each case. These figures, both experimental and theoretical, corroborate very closely the figures given in answer to this question. There are numerous influences, principally atmospheric, that alter the velocity of sound. The intensity of the sound also affects its velocity. The moisture of the air in the shaft would have the effect to increase the velocity of the sound. Taking these facts into account we consider the velocity of 1,125 feet per second, at a temperature of 60° F., as very close in this case.

It is further suggested by this correspondent that there is no formula given in the answer, for finding how far a body will actually fall in a given time, and he recommends the use of the formula, $D = t^2 \times 16\frac{1}{2}$. The formula given in the answer is the formula employed to calculate the time of the fall through a distance D , and is $t = \sqrt{\frac{2D}{g}}$. It will be observed that this is the same identical formula transposed, as suggested above, but our correspondent takes the value of $\frac{g}{2}$ as $16\frac{1}{2}$, making $g = 33$, whereas the correct value is $g = 32.16$ for this latitude.

We believe the endeavor we have made to make this Department practical, clear, and concise, is appreciated by the increasingly large number of contestants. In all cases it is the aim to quote only figures from the highest authorities. Although we cannot always give ourselves the pleasure of a reply, we assure contestants that their criticisms are appreciated, and whenever new light is thrown upon a subject by such criticism the same will be published together with our reply in the correspondence columns. We notice a slight typographical error occurred in the answer to Ques. 573, page 507, June 1900. In the next to the last line of this answer the radical sign was omitted from the expression $\frac{2D}{32.16}$.

This should read $\sqrt{\frac{2D}{32.16}}$ as in the fourth line above. This does not affect the answer.—EDITOR.]

TRADE NOTICES.

Babcock & Wilcox boilers have been awarded Grand Prix at the Paris International Exposition.

The Westinghouse Air Brake Co. has just ordered from The Burt Mfg. Co., of Akron, Ohio, a large Cross Oil Filter to equip its power house.

The Sullivan Machinery Co., of Chicago, wish to give notice that they have recently opened a branch office in Spokane, Wash., at 101 S. Howard St. This office is in charge of Mr. M. J. Ready, and the firm will carry there a complete line of rock drills, diamond drills and supplies for same.

The Sullivan Machinery Co., of Chicago, has moved its offices from 54-60 North Clinton St., to the Merchants Loan and Trust Building, 135 Adams Street, Rooms 1220-1221 where the Officers of the Company will be very glad to see their friends. The store and shipping department will remain on Clinton St.

The Jeffrey Mfg. Co., of Columbus, Ohio, announces in its advertisement on another page that its new chain catalogue is now ready for distribution. As this firm has a well established reputation in the line of chains and chain belting it will pay any one interested to write for this catalogue, which will be sent for the asking.

Owing to erroneous information we stated in the last issue of MINES AND MINERALS that the Grand Prize for mining machinery at the Paris Exhibition was awarded The Rand Drill Co. We are informed by them that this was an error and that while the Rand Co. received three gold medals, they did not receive the Grand Prize.

The Rand Drill Co. has removed its main office from 100 Broadway, New York, to the 15th floor of the new building just erected by the American Exchange National Bank, at 128 Broadway, corner of Cedar St., to which place all future correspondence should be addressed. In its new office the company will occupy

the entire floor in conjunction with its allied interests: The Pneumatic Engineering Co., the Rendrock Powder Co., and the Davis Calyx Drill Co.

The Jeffrey Mfg. Co. has recently received notice from the Director of Machinery and Electricity of the United States Commission to the Paris Exposition that the Jeffrey Co. has received a gold medal in class 63; a silver medal in class 23 and a bronze medal in class 21. These classes cover chain belting, elevating and conveying machinery and coal mining machinery.

The Aultman Co., engineers, founders and machinists of Canton, Ohio, has arranged with the C. T. Patterson Co., Ltd., of New Orleans, La., to represent the Company in the sale of its complete line of elevating, conveying and power transmission machinery. A competent engineering force will be at hand to give prompt and intelligent attention to all inquiries received for this class of machinery.

The Pittsburgh Gage & Supply Co., of Pittsburgh, Pa., manufacturers of the Pittsburgh safety water column which is a very simple and effective device and one that is claimed to automatically and unfailingly protect the steam boiler. Notwithstanding the precautions taken in the manufacture of steam boilers to make them safe they are nevertheless liable to accidents which are disastrous to life and property, but when provided with a safety water column this danger is largely obviated. The happy and effective combination of simplicity, durability and accuracy has made the Pittsburgh Safety Water Column a winner in its particular field and the Pittsburgh Gage & Supply Co. is having a highly satisfactory trade in these water columns, requiring its factory to be in operation night and day. The literature of the company is bright, pointed and very handsomely gotten up and well worth the reading.

The Thornton N. Motley Co., 43 John St., New York City, licensees for Eastern United States and foreign countries for the sale of the Jackson Hand Power Rock Drill, report that in the week ending July 14 they received orders from France, Nova Scotia, Mexico and two South American countries. Aside from the above they have made sales in Hawaii and to a number of leading concerns in the United States. Jackson drills are now in use in a large portion of the leading mining camps in the Western United States, in Hawaii and the following foreign countries: Belgium, France, Germany, Russia, New Zealand, Australia, Honduras, Cuba, Colombia, Mexico, Nova Scotia, Canada and Siberia. The above named licensees report that one sale in August was of 15 drills to a West Australia party and orders received in September before the first week had expired amounted to 35 drills for September delivery.

The Cherry Chemical Co., 1215 Filbert St., Philadelphia, Pa., manufacturers of the Red Seal boiler compound, state that their agent in Tien Tsin, China, has returned safely to the United States. While this will temporarily interfere with their business in Asia, they believe in a short time that their export trade will largely increase. They have recently received a letter from China, stating that the compound has given satisfaction far beyond the expectation of the user. This compound is manufactured dry, in the form of a granulated powder, in appearance resembling common brown sugar. It is put up in half barrels, barrels and kegs, weighing from 100 to 1,000 pounds, for the convenience of large and small customers. It readily dissolves in hot water, and can be applied in a dry state through the man hole, or in a liquid state through the feed pump. The makers claim that when this compound is used according to the directions, it will never fail to meet the most sanguine expectation of the purchaser, being composed of chemicals which are harmless to the boiler material. This compound has been endorsed by professional men and many of the very best engineers.

Correction, Answers to Examination Questions.

[In the answer to Ques. 13, page 134 of the October issue, the formula at the top of the second column should read,

$$d = \sqrt[3]{\frac{u}{.7854 prn}} = \sqrt[3]{\frac{12 \times 750 \times 33,000}{.60 \times .7854 \times 71.1 \times 1.4 \times 150}} = 34.8 \text{ in.}$$

And in the second line following, for the length of stroke we have, $34.8 \times 1.4 = 48.7$ inches. The size of engine required for this hoisting is, therefore, say $35'' \times 48''$ instead of $14'' \times 20''$ as stated. This was an error of calling u the work in foot-pounds instead of inch-pounds, and omitting the factor 12 from the above equation. The size of this engine could be much reduced by employing a second motion engine, geared say 1 to 4, or by using a double-deck cage and hoisting two cars at a time.

Attention was called to this omission by Mr. Chas. Power, Manager Issaquah Coal Company, Seattle, Washington, to whom we are indebted for the kindness.]

THE DEEPEST MINE IN IDAHO.

The Ramshorn, at Bayhorse—The Mineral Wealth of the Region. Its Development and Geology.

Written for MINES AND MINERALS, by R. N. Bell.

In the Ramshorn Mine of Bayhorse, Custer County can claim the distinction of having the deepest and best developed copper-silver mine in Idaho.

This famous old property was worked very extensively during the eighties, and produced silver, copper and gold bullion to the value of \$2,500,000.

The principal values being in silver, active production of ore at the mine was discontinued when the white metal commenced to suffer such a rapid decline in value. A small force of men, however, has been kept constantly employed on the property entirely on development work, and the mine has since only shipped two or three carloads of selected ore, each year, sufficient to pay current expenses.

Today, the Ramshorn Mine, has six miles of open workings, exposing measurable bodies of ore, which according to conservative estimates, contain an aggregate gross value of \$3,000,000. Besides which, all the surface ore bins, and most of the chutes and cross cuts in the mine, are stacked full of loose ore, ready for shipment. There is fully 3,000 tons of this loose ore, and its average value in silver and copper is \$100 per ton.

The canyon of Bayhorse Creek in which the Ramshorn Mine, and most of the other big mines of the Bayhorse District, are situated, is deep and narrow, and presents an elaborate cross section of the geology of the region, as it cuts the formations almost at right angles to their trend.

The formations embrace various horizons, from the Carboniferous blue limestone, down to the Archean granite. Associated with them are to be found enormous intrusions of diorite, syenite, quartz porphyry, and other more recent igneous rocks, together with the usual evidence of faulting, folding and fissuring, generally accompanying these formations.

This is a combination of geological and physical conditions, which has come to be recognized the world over as the most reliable manifestation of the presence of great mineral wealth, and in the State of Colorado this combination is regarded as almost essential in the establishment of successful mining camps, and the prolific production of the precious metals.

The exposed granite core of this portion of the Salmon River Range, at the head of Bayhorse Canyon, is overlaid by a thick series of heavy bedded Cambrian quartzite, and above the quartzite, several thousand feet of dark colored metamorphic slates. Overlying the slate again, come a series of Carboniferous blue and grey limestone, and dolomite, nearly 1,000 feet thick, and above the lime the foothill formations for a width of two miles are made up of tertiary lavas, tuffas, and recent sediments.

This same series of formations in the same general order, flanks the southeast slope of the range in a crescent shaped sweep for a distance of 30 miles, and is extensively mineralized the entire distance.

The Ramshorn vein is a compound fissure, cutting across the bedding planes of the thick series of metamorphic slates, almost at right angles. It courses north and south, and dips west, at an angle of 50 degrees.

The pay streaks occur on either wall of a zone of crushed slate. They are about 60 feet apart, along the upper workings, and give the appearance of two closely parallel veins. But as development was extended down, these pay veins gradually approached each other, and in the lower levels of the mine, are not to exceed 20 feet apart. They will probably unite at further depth, and make one strong vein of pay ore. The pay shoots now exposed in the various levels, are from six inches to six feet thick, and carry values of from \$25 to \$500 and \$1,000 per ton. The walls are clean cut, and well defined, and the mineral readily separates from the gangue.

The principal minerals contained in these pay veins, are brown and white carbonate of iron, mixed with chloride of silver and gray copper, with very little quartz. In the upper workings of the mine, the rich sandy brown chloride predominates, but in the lower levels, the copper sulphides are in excess. The writer sampled one shoot of clean gray copper ore, over 24 inches thick, that yielded an average value of 1,200 ounces of silver, and 25 per cent copper, and was informed that these shoots of clean high grade ore, sometimes swelled to four feet wide, and that the average of all the ore mined had been in excess of 100 ounces of silver.

Nature did a good deal for the development of the Ramshorn vein. The narrow canyon of Bayhorse Creek, is equivalent to a vertical shaft, already dug. The vein courses square into the north side of the canyon, and is covered by five contiguous claims,

following its apex for nearly 7,000 feet, and giving a vertical lift of something like 4,000 feet between the point where the vein crosses the creek level and the extreme north end of the property.

The method of development consists of a system of adit tunnel lifts driven in on the vein, at intervals, as it courses down the face of the mountain, and connected underground, with a regular system of raises, chutes and manways, for the ventilation and economical handling of the ore bodies.

At the mouth of the principal tunnel openings, there are substantial ore bins, arranged to feed a Halliday wire-rope tramway, by which they are all connected to the principal storage bin at the foot of the mountain, now filled with 1,000 tons of loose ore having an average value of 100 ounces of silver, and about five per cent copper.

There is sufficient stoping ground now opened on the numerous ore shoots, to accommodate 250 miners breaking ore, without being in each other's way. This ore carries an excess of free smelting iron, and with its other advantages, and railroad transportation added, this property will prove one of the most profitable mines in the state.

The longest tunnel on the Ramshorn, which is driven in on the vein all the way, was started several hundred feet above the creek level. It has penetrated the mountain 3,000 feet, and shows a handsome body of ore in the present face, nearly three feet wide. The steep pitch of the mountain, into which this vein and tunnel course, gives a vertical face depth of 3,000 feet. This tunnel together with its miles of connections probably constitutes the deepest development of any ore vein in the State of Idaho, and amply refutes the argument that Idaho mines do not go down.

Nearly parallel to, and adjoining the Ramshorn Mine, the old Skylark Group, carrying the same character of ore in the same formation, has been a famous producer. This mine has been worked continuously, for the past 20 years. It is also developed by a succession of adit tunnel lifts with systematic underground connections aggregating something like 18,000 feet in length. It has produced gold, silver and copper bullion to the value of \$2,500,000, and shipped \$25,000 worth of ore last year. The Skylark vein was more irregular and disturbed in its upper workings than the Ramshorn, but in its lower levels it shows a more regular tendency and steeper pitch, and the indications are that its greatest resources of mineral wealth still await systematic development in depth, which can be continued by successive adit tunnel lifts for fully 3,000 feet farther down the side of the mountain before the apex of the vein would strike the Creek bed, on its present course.

The longest tunnel on the Skylark is 2,400 feet, which carries the regular fissure wall of the vein throughout its entire length. This tunnel is still being pushed ahead, and a shoot of rich ore has been developed on its course within the past month.

Besides these two great properties, there are numerous other mines and prospects on the slate belt, extending for miles in a north and south direction, most all of which are idle at the present time, owing to the low price of silver, and the lack of transportation facilities. The most notable of these are a group of mines on Poverty Flat Mountain, which have been worked at a comparatively shallow depth, but have a bullion record of \$1,500,000.

Some of the fissures in the slate belt are very irregular in their upper horizons, but persistently continuous, and I believe will go down to an indefinite depth, and probably carry much more regular values when the underlying igneous rocks that produced them have been reached. This intrusion of igneous matter, which is partially manifested by a laccolitic crown in the bottom of the canyon below the Ramshorn and Skylark mines, must have been of phenomenal proportions, as there is unquestionable evidence that it has thrown out intrusive sheets miles in extent, underlying the whole southeast slope of the range.

These conditions offer the most inviting field for deep mining, especially in the lead belt, where the results already obtained, I believe, are only a trifling surface manifestation of what lies below.

This great intrusion of igneous rock is responsible for the gradual folding and faulting of the sedimentary formations into the parallel line of mountain uplifts, constituting Ramshorn, Keystone, Poverty Flat, and Bald Mountains, which reach elevations 9,000 to 10,500 feet above sea level, and one to three thousand feet above the main granite divide, or water shed of the district, separating the waters of Yankee Fork from the Salmon River.

Three miles below the Ramshorn Mine, around the town of Bayhorse, are situated some very fine lead-silver properties, among which the principal producers have been the Beardsley, Excelsior, River View, and the Silver Brick Mountain mines. Most of these, with the exception of a few small leased properties, are idle at the present time. None of the groups mentioned have reached a vertical depth of over 500 feet, and their aggregate production already exceeds \$2,000,000.

These veins are nearly vertical fissure or fracture planes, cutting through the gently tilted beds of blue-gray crystallized lime and dolomite. The limestone beds have been very much fractured and dolomitized, brecciated, and re-cemented together. The pay ore is uniformly high grade, averaging for the entire camp fully 40 per cent. lead, and one to three ounces of silver for each unit of lead. It is usually a mixture of galena, hard carbonate, and sand carbonate of lead, associated with chloride, sulphide and bromide of silver, manganese, carbonate of iron, and occasionally a little zinc.

The ore occurs in thin seams, lining the walls of the fissures, and occasionally makes into pockets and great irregular bonanza chambers of clean ore. One of these chambers on the Beardsley-Excelsior group produced over one-half million of dollars worth of silver and lead ore.

Although the arrangement is different, people familiar with the geology of Leadville, will recognize in the above brief outline, the principal elemental conditions of Colorado's most famous camp, with the single, but most important exception of the horizontal porphyry dikes.

The serrated, fractured and brecciated bluffs of Carboniferous lime and dolomite in which the principal lead mines are situated, and which are filled with a network of lead mineral manifestations, in their immediate vicinity, appear particularly devoid of porphyry. Yet their condition is such as might have been produced by the steady intrusion of igneous matter into their foundation layers, and the subsequent solfataric emanations that would be apt to follow it. And as a matter of fact, the belt of foot hills, flanking the lime formation, is underlaid for miles by at least two intrusive sheets of blocky quartz porphyry, or porphyrite, 10 to 50 feet thick, whose prevailing tints and conspicuous mineral constituents point almost conclusively to their origin in the main vent of similar igneous matter near the head of the canyon. They are exposed by occasional outcroppings in the small cross cutting streams that drain this double mountain uplift, and at one point the upper porphyry sheet is exposed within 300 feet of the lowest outcropping lime horizon, but its actual contact is obscured by debris.

If the fractured and altered condition of this lime belt, was brought by, and subsequent to, the intrusion of these porphyry sheets, then the prevalent mineralization unquestionably came from the same source. And these conditions point to a probable underlying resource of bedded contact bodies of silver-lead ores, that may prove to be of enormous extent and commercial importance.

This most interesting, and I might say, pronounced Leadville feature of this district, has apparently been entirely overlooked by the miners and engineers who have had charge of its development. No attempt has been made to open up the underside of these beds, or dikes of intrusive porphyry at any point. In fact they have never been touched, except at one place near the mouth of Bayhorse Canyon, where a small quarry was opened on the lower dike, for the purpose of extracting the desirable blocky building stone it afforded.

This lead belt is only one of several well defined courses of lead-silver bearing formations in Custer County. It is the most persistently mineralized however of any of them, and shows a variety of surface manifestations, that should prove a paradise for Colorado prospectors, familiar with the lead-silver bearing contact formations.

There are dozens of fine prospects that have been abandoned since the slump in silver, and some of them good mines, with considerable development. Seven miles south of Bayhorse, the Centennial and Homestake mines have been large producers of rich ore. These are contact veins between blue lime and steep pitching dikes of porphyry. At Clayton, 12 miles south of Bayhorse, the Ella mine carries a well defined fissure vein, in lime and quartzite, filled with carbonate of iron, and rich concentrations of gray copper ore. This mine had one pipe of steel galena ore, about 10 by 20 feet, that was followed down to water level, and produced over \$400,000 worth of silver-lead bullion.

Adjoining the Ella on the same strike, the Rob Roy Group has considerable development, exposing a large vein of 20 per cent. lead ore, worth 20 ounces in silver. This group has several parallel veins of iron and shows considerable sulphate of barite or heavy spar, that infallible blossom of rich ore among the Aspen mines, the probable importance of which does not seem to have been half appreciated in this district.

Three miles south of the Rob Roy on the east side of Squaw Creek, the Red Bird mine is located on a big zone of blocky blue lime, that carries a line of bold croppings and blowouts of carbonate of iron, plainly traced along the surface for six miles.

The Red Bird is developed to a depth of 400 feet, and a lateral extent of not to exceed 1,000 feet, by adit tunnels. The ore in this mine consists of hard and soft carbonate of lead and galena, well mixed with carbonate of iron and sufficient lime to

make it self-fluxing. It has already produced \$700,000 worth of lead-silver ore, that yielded an average value of not less than 30 per cent. lead and 30 ounces of silver per ton, a good deal of the ore running much higher. Six miners turned out 30 tons of ore a day for 90 days last summer, while the Company's smelter at Clayton was running.

On the opposite steep slope of a synclinal trough, that forms the bed of Squaw Creek, in what is probably the same lime horizon, the Saturday and Molly D Mines have shipped several hundred thousand dollars worth of ore, that averaged over 50 per cent. lead and 50 ounces in silver.

Continuing south about ten miles farther, on the opposite side of Salmon River, at the head of Slate Creek, the Silver Rule Mine was a bedded deposit of hard gray carbonate of lead. It has produced \$350,000 worth of ore, yielding 60 per cent. lead and 60 to 150 ounces of silver, together with \$5 to \$8 in gold. The importance of a system of narrow vertical fissures filled with granular quartz and a good sprinkling of the same high grade lead-silver ore, that terminates on the underside of the bedded vein seems to have been overlooked. The mine is now idle. These fissures are probably the fountain source of the bedded deposit, and their further exploration may develop a still more profitable resource of ore than that already mined.

A short distance still farther south of the Silver Rule, the Livingston Group of mines, consisting of seven claims, and owned by some Denver people, makes one of the most handsome showings of high-grade lead-silver ore in the State. This vein is in lime, slate, or shale, and associated with dikes of granular pyritiferous porphyry, which gives it every appearance of permanency. There is seven or eight hundred feet of development on this property, distributed in short tunnels, driven in on the ore and proving its continuity for over 2,000 feet in length. The pay-streak is from 6 inches to 3 feet wide of the same hard gray carbonate of lead, as that found in the Silver Rule mine. It gives average values of 50 to 70 per cent. lead, and 50 to 500 ounces in silver and \$5 to \$20 in gold. There have been several carloads of selected ore shipped from this mine that yielded over 60 per cent. lead and 300 ounces of silver per ton.

On the opposite side of the divide, two miles distant, the same Denver people own another property, which they call their low grade mine. This is a large vein of sand carbonate, and galena ore, associated with some zinc, and carries big strong shoots of clean ore, 2 to 8 feet wide, that yielded average values of 50 to 60 per cent lead and 20 to 40 ounces in silver.

The Salmon River range or aggregation of rough mountains and canyons, which divides the waters of Middle Fork from the main Salmon River, and extends from the head of Cape Horn Creek to Shoup, a distance of 75 miles in an air line, contains numerous districts and belts of mineral besides the one just described and their various mines have a bullion record of not less than \$50,000,000. Of this magnificent yield, fully 30 per cent was in gold, 15 per cent in silver and 5 per cent lead and copper.

The baser metals in this region have been avoided and neglected principally by reason of lack of transportation facilities. But if the present commercial magnificence of the United States continues, the extensive deposits of copper lead, iron and other useful metals here manifested will doubtless soon attract the attention of capitalists, and form the basis of large industrial enterprises.

The prevailing formation of this range is granite of varying types, from fine schisty gneiss to the coarsest bird's-eye variety, with porphyritically developed crystals of orthoclase feldspar of extraordinary size,—from 2 to 4 inches in the direction of their vertical axes. The prevailing color is gray, but in the old Loon Creek placer district, west of the great volcanic peaks of the Custer and Bonanza gold belt, there is a large area of country showing the deep pink variety similar to the Pike's Peak and Cripple Creek type.

Since Archean times this range has been subjected to an enormous amount of volcanic disturbance, which has produced a great variety of cosmic effects, from a simple fold to the intrusion of a succession of great laccolithic mountain peaks, filling whole districts with rich gold-bearing igneous rocks.

At one place in Lemhi County, there is evidence of the complete subsidence of the original summit of this grand old range, which for several miles is sunken into a narrow synclinal trough of coarse Archean granite, and now forms the bed of Big Creek, misnamed Napias Creek, on the map of the State of Idaho, recently issued by the U. S. Land Office.

This great earth movement resulted in a parallel mountain uplift, on both sides, eight to nine thousand feet high, capped with Silurian sediments, and produced lines of shearing and dynamic disturbance, together with igneous intrusions, which tapped a reservoir of copper and gold in the Blackbird District. This district promises to develop one of the most extensive and profitable resources of those metals ever discovered.

Besides gold, silver, copper, lead, and iron, there is a great variety of other useful metals and minerals in this region. Among these the writer has collected high grade specimens of cobalt, nickel, bismuth, tin, antimony, zinc and mercury ores; some rough crystals of sapphire; gem opals, worth \$10 per carat; fine specimens of fluor spar and cryolite, and a great profusion of garnets. Traces of platinum and palladium have also been found in some of the placer gravels.

The origin of these ores and metals is plainly manifested by modern solfataric action in hundreds of hot mineral springs, distributed over the entire length and breadth of the range, and in some places emanating directly from rich mineral bearing veins.

This is one of the best watered and timbered ranges in the West, and with the magic influence of railroad transportation, its future importance as a wealth producer can hardly be over-estimated.

A preliminary survey has been made by the Idaho Midland Railway Company, on a proposed line, to be run from Boise City, Idaho, to Butte, Montana. Should this line be built, and there is a very bright prospect for it at the present time, it will run down the Salmon River, along the east slope of this range its entire length, and be assured an immense tonnage of mineral freight right from the start.

The next legislature of Idaho would do much for the advancement and general welfare of the State by providing for a State Mineralogist and Mining Inspector, to take the place of the present office of Mine Inspector. And the position should be filled by a man of recognized ability, with sufficient salary and ample appropriation at his command. His duties should be, not only to inspect working mines, but to visit new camps, districts and discoveries, and make quarterly or annual reports of the mineral resources of the State, by districts, sections and counties. The interior mountain fastnesses of Idaho, contain rich volumes of mineral information, that the world should possess, and if presented under the authority of the government, it would result in bringing more capital to the State than any other method that could be devised.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

SCRANTON STEAM PUMP Co., Scranton, Pa. "Straightways." 17 page pamphlet.
 SCULLY STEEL & IRON Co., Chicago, Ill. September and October 1900 Stock List. 120 pages.
 DENVER ENGINEERING WORKS Co., Denver, Colo. Bulletin No. 1003, "Electric Hoists."
 OTTUMWA BOX CAR LOADER Co., Ottumwa, Iowa. "The Ottumwa Box Car Loader." 16 pages.
 PHOSPHOR-BRONZE SMELTING Co., 2200 Washington Ave., Philadelphia, Pa. Price List No. 17, 19 pages.
 JEANESVILLE IRON WORKS Co., Jeanesville, Pa. "Steam and Electric Sinking Pumps." 4 page circular.
 L. SCHUTTE & Co., Philadelphia, Pa. Contractors for Hydraulic and Special Machinery. 4 page circular.
 CHICAGO HOUSE WRECKING Co., West 35th & Iron Sts., Chicago, Ill. Special List No. 109, and Catalogue No. 110.
 THE DENVER FIRE CLAY Co., Denver, Colo. 280 pages containing views of the different things made by this Company.
 GENERAL ELECTRIC Co., Schenectady, N. Y. "Electric Mine Locomotives." 46 pages very well gotten up and handsomely illustrated.
 WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburgh, Pa. Circular No. 1030, "O. D. Transformers"; No. 1031, "Belt-Driven Polyphase Alternators."
 JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. Graphite for Automobiles, 8 page circular. "Covering Capacity and Great Durability of Dixon's Silica-Graphite Paint."

AMERICAN DIAMOND ROCK DRILL Co., P. O. Box 1442, New York, N. Y. "The Diamond Drill and Its Work." 44 pages well illustrated and containing a number of testimonials.

PITTSBURG GAGE & SUPPLY Co., Pittsburg, Pa. "A Safe Line to Tie to, Pittsburg Steam Specialties." Pamphlet, 16 pages. Also, "Two Steam Specialty Stars," 6 page circular.

DEAN BROS. STEAM PUMP WORKS, Indianapolis, Ind. Catalogue No. 42, 1900. 72 pages well illustrated showing many different types of pumps manufactured by this well known firm.

FAIRBANKS, MORSE & Co., Chicago, Ill. "Pumping Engines Operated on Gasoline, Gas or Distillate." 40 pages containing a great many testimonials of firms using these pumping engines.

B. F. STURTEVANT Co., Boston, Mass. Bulletin S. "4-Pole Motors and Generators." 4 page circular. Catalogue No. 101, "Steel Plate Planing Mill Exhausters." 40 pages nicely gotten up and well illustrated.

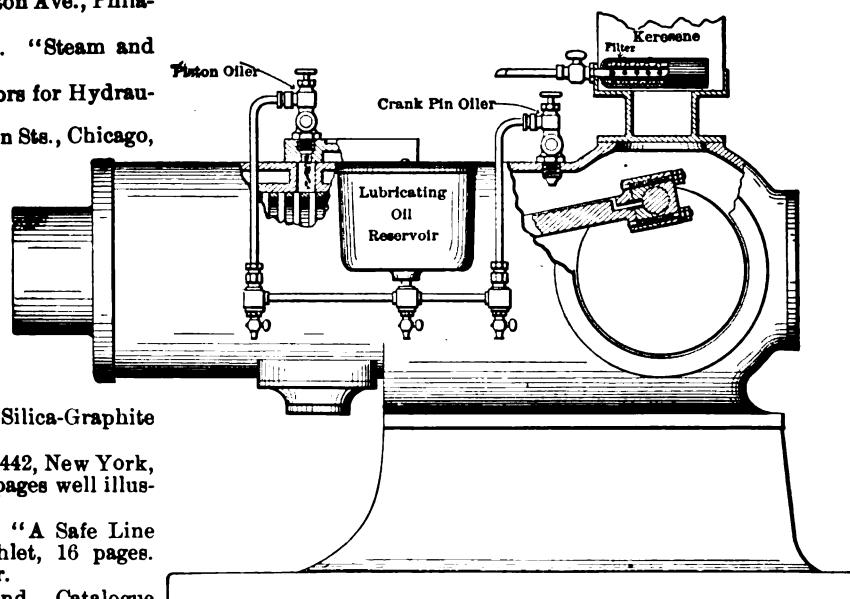
SAMUEL HARRIS & Co., 23 S. Clinton St., Chicago, Ill. "Tools and Supplies of all kinds for Machinists and Manufacturers." 480 pages showing views of many of the different kinds of tools manufactured by this firm.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Circular No. 10, "Light Locomotives"; No. 11, "Passenger or Freight Locomotives"; No. 15, "Compound Freight and Passenger Locomotives"; No. 16, "Consolidation Freight Locomotives"; No. 17, "Compound Freight Locomotives"; No. 18, "Consolidation Freight Locomotives"; No. 19, "Compound Freight Locomotives"; No. 20, "Six-Wheels-Connected Switching Locomotives"; No. 21, "Six-Wheels-Connected Switching Locomotives"; No. 22, "Atlantic Type Locomotives for Passenger Service"; No. 23, "Compound Atlantic Type Locomotives for Passenger Service"; No. 24, "Light Six-Wheels-Connected Switching Locomotives"; No. 25, "Six-wheels-Connected Switching Locomotives Tank on Boiler"; No. 26, "Tank Locomotives"; No. 27, "Four-Wheeled Switching Locomotives with Separate Tender."

Kerosene Engine.

The Kerosene Engine here illustrated and made by August Mietz, 128-138 Mott St., New York City is becoming a very popular motor where gas is not available for a gas motor. These engines furnish a safe and reliable power and they are claimed to be perfectly safe, while insurance companies do not object to their installation. They are operated with ordinary kerosene oil and can therefore be used wherever this oil is procurable. The makers state that they consume about 1 pint per horsepower per hour, the amount being automatically regulated to the power used by a governor, the motor maintaining a uniform speed. The automatic igniter does away with an electric spark or tube igniter and thus any source of trouble from internal combustion is avoided; this feature combined with the constructional simplicity of the engine renders it particularly useful and reliable even in the hands of untrained attendants. An enclosed crank shaft renders the engine dust proof. It is also extremely rigid, self lubricating and there is no odor from the piston. The oil for the crank drops into the groove on top of the rod whence it finds its way along to the pin and these automatic oiling devices operate only when the engine is running. When the engine is to be stopped it is only necessary to throw up a small finger which regulates the oil supply.

The advantages claimed for these motors by the makers over steam and other forms are as follows: They require no engineer, no water is consumed, there is no handling of coal or ashes and they can be very quickly started and require no attention except



oiling. They are said to be strong and more durable than a steam engine and boiler and take up less room. Blueprints and catalogues can be obtained from the maker, Mr. August Mietz at the address given above.

COMPRESSED-AIR HAULAGE-PLANT

At No. 6 Colliery of the Susquehanna Coal Company, Glen Lyon, Pennsylvania.

By J. H. Bowden, Wilkes-Barre, Pa.*

The shaft-plant here described was put in operation in September, 1895, and the No. 6 slope-motor was started in May, 1896.

The plant comprises: One Norwalk three-stage compressor 12 $\frac{1}{2}$, 9 $\frac{1}{2}$ and 5 in. diameters of air- and 20 in. diameter of steam-cylinder, all 24 in. stroke; capacity at 100 revolutions, 296 cu. ft. of free air per minute, compressed to 600 lbs. per sq. in. A main pipe, 5 in. diameter, 4,380 ft. long, with five charging stations in No. 6 shaft, and a branch of 3 in. pipe, 3,100 ft. long, with three charging stations, in No. 6 slope. These pipes on each line charge a Porter compressed-air motor, with 7 $\times$ 14 in. cylinders, and four 24 in. drivers, weighing about eight tons, with a tank capacity of 130 cu. ft. of air at 550 lbs. pressure in the main tank, reduced to 160 lbs. in the 8-in. auxiliary tank of 4.2 cu. ft. capacity, supplying the cylinders. The No. 6 shaft run averages 4,000 ft. each way on grades of $\frac{1}{2}$ to 2 $\frac{1}{2}$ per cent., and averaging close to one per cent. in favor of the loaded cars. The No. 6 slope run averages 2,100 ft. with nearly the same grades. The mine cars weigh 2,800 lbs. empty, and about 9,800 lbs. loaded, and are hauled in trips of 12 to 20, averaging about 15 cars. The shaft-motor now hauls about 355, and the slope-motor 320 cars per day of 10 hours, replacing in the shaft 17 mules, and in the slope 15 mules, or, in all, 32 mules, against 27 replaced in 1896.

The average daily car- and ton-mileage of each motor was as follows:

	Cars Hauled.		
	1896.	1897.	1898.
No. 6 Shaft-motor.	355	347.4	356
	Tons Hauled One Mile.		
	1896.	1897.	1898.
Empty, in	336	330	338
Loaded, out	1,180	1,155	1,183
Total	1,516	1,485	1,521
Net load	844	825	845
	Cars Hauled.		
	1896.	1897.	1898.
No. 6 Slope-motor.	288	288.7	319.2
	Tons Hauled One Mile.		
	1896.	1897.	1898.
Empty, in	143	144	160
Loaded, out	501	504	540
Total	644	648	720
Net load	358	360	400
Total for both motors, gross (including empty cars returned)			
	1896.	1897.	1898.
	2,160	2,133	2,241
Net load			
	1,202	1,185	1,245

The use of steam and air in operating the compressor and motor was found by test to be:

Steam.

Indicated horsepower at 181 revolutions of compressor	150 H. P.
Steam-consumption per H. P. per hour, from cards	34 lbs.
Steam-consumption per hour	5,100 lbs.
Steam-consumption per hour including condensation in line	5,200 lbs.
Boiler horsepower required	174 B. H. P.
Evaporation per lb. of coal (cylinder boilers)	5 lbs.
Coal required per hour	1,040 lbs.
Coal required per day, 10 hours	10,400 lbs. 4.65 tons.
Cost of fuel and firing per day (10 hours) 4.65 tons, at 50c.	\$2.32

Air.

Compressor Capacity.—The free air compressed per revolution of compressor is 2.96 cu. ft., according to the calculation of the Norwalk Iron Works Co., no allowance being made for leakage. The compressor works 12 hours per day; the motors 10 hours.

	Cu. Ft.
Free air per minute at rated speed of 100 revolutions	296
Free air per minute at actual speed of 131 revolutions	387.8
Free air per day 12 hours at rated speed of 100 revolutions	213,120
Free air per day 12 hours at actual speed of 131 revolutions	279,216

Capacity of Air-Mains Used as Reservoirs.—The capacity of the 5-in. line, 4,380 ft. long, is 608 cu. ft.; and that of the 3-in. line, 3,100 ft. long, is 159 cu. ft., making the total for both lines 767 cu. ft.

At 600 lbs. pressure these lines hold 32,505 cu. ft. of free air. The capacity of the main and auxiliary tanks is 134.6 cu. ft. At 508 lbs. pressure (at which they will equalize with the main, start-

ing to charge at 600 lbs.), this is equivalent to 4,845 cu. ft. free air.

Leakage of Air-Mains.—In standing 12 hours the pressure falls from 550 to 350 lbs., and of free air, 11,688 cu. ft., or 974 cu. ft. per hour, are lost. The proportion of this leakage to the total air compressed is 4.18 per cent.

Air Used by Motors.—According to a test made March 29, 1900, the amount of air used for the given amount of work was as follows:

	Shaft-Motor.		Slope Motor.
	No. 2 Plane.	No. 3 Plane.	
Number of trips empty	8	10	16
Number of trips loaded	8	10	15
Average No. of cars per trip, empty	15.83	12.7	11.4
Average No. of cars per trip, loaded	18	13	11.3
Average cu. ft. of free air per trip, empty	1,724	5,686	1,230
Average cu. ft. of free air per trip, loaded	1,631	1,898	599
Average cu. ft. of free air per round trip	3,855	7,584	1,829

Summary of Day's Work in 1898.—At shaft No. 6, 356 cars were hauled per day; namely, from No. 2 plane, 6 trips of 15 cars each, using 20,130 cu. ft. of free air, and from No. 3 plane, 20 trips, averaging 13.2 cars each, using 151,680 cu. ft. of free air. The work at Slope No. 6 was 320 cars per day in 28 trips, averaging 11.4 cars each, and using 51,212 cu. ft. of free air, making a total for 676 cars of 223,022 cu. ft. of free air. The amount of free air apparently compressed for this work was 279,216 cu. ft., of which 83.4 per cent. is accounted for, leaving 16.6 per cent. for leakage and slip in the compressor, leakage in air-lines, and changes in temperature.

Air Used Per Ton-Mile.—The average volume of free air used per ton-mile is as follows:

	Cu. Ft.
No. 6 shaft-motor, gross	113
No. 6 shaft-motor, net	203
No. 6 slope-motor, gross	71
No. 6 slope-motor, net	128
Both motors, gross	100
Both motors, net	180

The greater quantity of air used by the shaft- as compared with the slope-motor is due to the heavier curves and the switching required, especially at No. 2 plane, where a portion of the trip is frequently left.

Cost of Plant.—The cost of plant, not including steam boilers, was as follows:

Compressor	\$2,880.00
Extras for compressor-repairs	75.75
Shaft-motor	2,743.63
Slope-motor	2,918.20
Extras for motor repairs	207.98
Air-connections, 5-in. line (6,000 ft.)	2,914.32
Air-connections, 3-in. line (4,000 ft.)	1,240.46
Steam-connections to compressor	278.27
Material for compressor-foundations and house, and air-washing box	295.27
Labor on compressor-house and foundations, and 5-in. line, and installing shaft-motor	1,183.01
Labor on 3-in. line and installing slope-motor	46.95
Foster equalizing-valves	872.21
Total cost of plant	\$15,156.03

Cost of Operation.—The operating expenses are shown in the following table:

	1897 (179 days worked).		1898 (160 days worked).	
	Per Day.	Per Year.	Per Day.	Per Year.
2 Motor engineers, at \$2.10	\$4.20	\$751.50	\$4.20	\$672.00
2 Brakemen, at \$1.60	3.20	572.80	3.20	512.00
1 Engineer for compressor, at \$2.32	1.16	207.64	1.16	185.60
Oil for compressor	.67	119.49	.47	75.94
Oil for motors	.25	45.08	.25	40.94
Repairs for compressors (material)	.10	18.76	.48	76.06
Repairs for compressors (labor)	.06	10.38	.09	15.22
Repairs for motors (material)	.16	28.78	.51	81.06
Repairs for motors (labor)	.18	32.77	.23	36.87
Steam for compressor (150 H. P.), fuel and firing	2.32	415.28	2.32	371.20
Total operating-expenses	\$12.30	\$2,202.78	\$12.91	\$2,066.93

Total Cost Including Fixed Charges.—The total actual cost in the two periods mentioned was therefore, for the two motors (one-half to each), in 1897, per day, \$22.23, and for the whole period, \$3,979.38; and in 1898, per day, \$24.01, and for the whole period, \$3,843.83. Taking the figures of 1897 as a basis, and

*A paper read before Canadian Meeting of The American Institute of Mining Engineers, August, 1900.

assuming 300 days of work in a year (with consequent saving in certain items of fixed charges, superintendence, etc.), it is estimated that the total cost would be \$18.22 per day, or \$5,466.60 per year. A similar calculation, based upon the figures of 1898, gives \$18.83 per day, or \$5,649.60 per year.

Fixed Charges.—The fixed charges are as follows:

	1897 (179 days worked).		1898 (160 days worked).	
	Per Day.	Per Year.	Per Day.	Per Year.
Interest, repairs and depreciation of 174-H. P. boilers	\$1.46	\$261.00	\$1.63	\$261.00
Interest and depreciation of plant, 10 per cent. on \$15,156	8.47	1,515.60	9.47	1,515.60
Total fixed charges	\$9.93	\$1,776.60	\$11.10	\$1,776.60

Cost Per Ton-Mile.—For the same two periods, the cost per ton-mile was as follows:

	1897 (179 days).			1898 (160 days).		
	Daily Ton-Mile-age.	Daily Cost.	Cost Per Ton-Mile.	Daily Ton-Mile-age.	Daily Cost.	Per Ton-Mile.
			Cents.			Cents.
No. 6 shaft-motor, gross	1,485	\$11.12	0.75	1,527	\$12.00	0.79
No. 6 shaft-motor, net	825	11.12	1.35	845	12.00	1.42
No. 6 slope-motor, gross	648	11.12	1.72	720	12.00	1.67
No. 6 slope-motor, net	360	11.12	3.09	400	12.00	3.00
Both motors, gross	2,133	22.23	1.05	2,241	24.01	1.07
Both motors, net	1,185	22.23	1.89	1,245	24.01	1.93

Cost of Mules Displaced by this Plant.—There were at No. 6 shaft 17, and at No. 6 slope 15 mules, costing, on an average, \$126.64 each, or \$4,052 for the two lots.

Operating Expense by Mules.—The expense of operating with mules would be as follows:

	1897 (179 days).		1898 (160 days).	
	Per Day.	Per Year.	Per Day.	Per Year.
No. 6 shaft.				
Depreciation and interest on 17 mules, 25 per cent.	\$3.01	\$538.22	\$3.36	\$538.22
Feeding, attendance, harness and repairs, \$141.40 per mule	13.43	2,403.80	15.02	2,403.80
6 drivers	9.40	1,682.60	9.40	1,504.00
6 couplers and spragmen	8.10	1,449.90	8.10	1,296.00
Total cost by mules	\$33.94	\$6,074.52	\$35.88	\$5,742.02
Cost by motor	11.12	1,989.69	12.00	1,921.77
Saving by compressed air	\$22.82	\$4,084.83	\$23.88	\$3,820.25
No. 6 slope.				
Depreciation and interest on 15 mules, 25 per cent.	\$2.65	474.90	2.97	474.90
Feeding, attendance, harness and repairs, \$141.40 per mule	11.85	2,121.06	13.26	2,121.06
8 drivers	8.00	1,432.00	8.00	1,280.00
5 couplers and spragmen	6.85	1,226.15	6.85	1,096.00
Total cost by mules	\$29.35	\$5,254.11	\$31.08	4,971.96
Cost by motor	11.12	1,989.69	12.00	1,921.77
Saving by compressed air	\$18.23	\$3,264.42	\$19.08	\$3,050.19
Both No. 6 shaft and No. 6 slope				
Total cost by mules	63.29	11,328.63	66.96	10,718.98
Total cost by motors	22.23	\$,979.38	24.01	3,843.53
Saving by compressed air	\$11.06	\$7,348.25	\$42.95	\$6,870.45
Total saving in two years				\$14,218.70
Total cost of plant				15,156.00

COST PER TON-MILE BY MULES.

	1897. Tonnage.			1898. Tonnage.		
	Ton-Mile-age.	Cost.	Cost per Ton-Mile.	Ton-Mile-age.	Cost.	Cost per Ton-Mile.
			Cents.			Cents.
No. 6 shaft.						
Gross	1,485	\$33.94	2.29	1,527	\$35.88	2.35
Net	825	33.94	4.11	845	35.88	4.25
No. 6 slope.						
Gross	648	29.35	4.53	720	31.08	4.32
Net	360	29.35	8.15	400	31.08	7.77
Total, gross	2,133	63.29	2.98	2,241	66.96	2.98
net	1,185	63.29	5.34	1,245	66.96	5.38

At the average rate of saving for 1897 and 1898, the entire cost of the plant would be saved in 361 working days.

The capacity of the shaft-motor is equal to fully double its present work, and the slope-motor is working at but about one-third of its capacity, while the compressor is doing all that it can, and a second one was ordered April 7, 1900. To operate the plant to the full capacity of both compressors, which, under the present conditions would be about 4,500 ton-miles gross or 2,500 net per day for 300 days per year, would bring the cost of operation, including fixed charges, to about \$24.60 per day, or $\frac{3}{10}$ of a cent per ton-mile gross and $\frac{3}{10}$ of a cent per ton-mile net load. If all the work could be done by one motor under the conditions of No. 6 shaft, up to the capacity of the compressor, for 300 days per year, using only one crew, the cost of plant would approximate \$11,000, and the operating expenses, including fixed charges, would be \$10.86 per day for 2,400 gross ton-miles, or $\frac{1}{10}$ of a cent per gross ton-mile and $\frac{1}{10}$ of a cent per net ton-mile.

A further reduction of cost would result from reheating the air at the motor, by passing it through water at the temperature of steam at 90 pounds pressure, by which method tests have shown a gain of about 50 per cent. in air-economy. It is probable that by this means one motor could be run to its full capacity (about 3,000 gross ton-miles per day) with one compressor, at a total cost of \$10.80 per day, or $\frac{3}{10}$ of a cent per gross ton-mile, for 300 days' work per year, the saving of $\frac{1}{10}$ of a cent per gross ton-mile, or about 20 per cent. over the last mentioned conditions being due only to the greater air economy; the fixed charges and labor-cost remaining practically the same.

For a detailed description of this plant, with illustrations, those who are specially interested are referred to the *Colliery Engineer and Metal Miner*, Scranton, Pa., for May, 1898, and to the Report for 1895 of the Pennsylvania Bureau of Mines, pp. 104 to 110.

Competition With American Kerosene in Australia.

Consul-General Bray, of Melbourne, under date of July 27, 1900, says he is reliably informed that the Shell Trading and Transport Company, of London, England, has secured sites in Melbourne and Sydney on which it will erect large refining works, the product of which will, it is anticipated, compete very keenly with American oil in those markets. The clipping reads:

At the meeting of the company held in London on the 21st of June, regarding the extension of the business to the colonies and other centers, the chairman said:

"In view of the very large supplies coming to us for marketing, it has been necessary, in the opinion of the directors, to widely extend the field of the company's operations, and accordingly arrangements have been concluded to extend the business to many new ports in China, and we still hope that, in spite of the trouble now prevailing there, we shall see the company's oil retailed in the streets of Peking before the end of the year. It is a matter of congratulation to the directors that they have been able to conclude arrangements with Messrs. Julius Weil to act as their agents in the Cape, this firm possessing unrivaled distributing media, and as soon as the war is over installations will be erected at the principal towns in the colony. Excellent sites have been secured in Melbourne and Sydney, and arrangements have also been made to extend this company's business to Adelaide, Brisbane, and New Zealand, the quality of the kerosene now being produced rendering it exceptionally suitable for the Australian markets. After great difficulties, we have also succeeded in obtaining permission to erect tank storage at the principal ports in Java, and sites have been acquired, as also at Zanzibar and Mombassa. The shareholders will thus see that the business is still in its infancy, and the directors consider it sound policy to have the company's business as widespread as possible, so that in case of competition, they may be free to choose the most remunerative markets throughout the world in which to place their products."

The chairman also stated that large sums have been invested by the company in purchasing and developing their fields in Borneo, and they have acquired an oil-bearing territory of about 460 square miles in extent, with an oil production which has exceeded 1,000 tons a day, and a refinery capable of dealing, when complete, with 3,000 tons of crude oil daily. The actual portion at work was handling 2,500 tons of crude oil per week, and by the end of August a second bench of stills would be at work, when the refinery could deal with 5,000 tons of crude oil weekly, and every effort would be made to complete the other two benches of stills already provided and awaiting erection. When the whole of the four benches of the refinery are at work, the income from Borneo products alone is expected to exceed £1,000,000 per annum. This is, of course, provided that the present supply of oil continues, and markets are found, and that present prices for the various products upon which the estimate is based are maintained.

THE PARIS EXHIBIT

Of the Ingersoll-Sergeant Drill Company—An Extensive Exhibit of Mining and Compressed Air Machinery.

One of the most extensive exhibits from the United States at the Paris Exposition is that of the Ingersoll-Sergeant Drill Co., of New York City, which company has exhibits of its air compressing, mining, tunneling, and quarrying machinery in three places. On the Champ de Mars, in the Palace of Machinery and Electricity, it has established its headquarters in the midst of the United States machinery section. Here, one of the company's Class "H" compressors is in operation, supplying air for all the pneumatic tool companies' exhibits and the tubular despatch of the Batcheller Pneumatic Tube Co. This compressor has duplex steam and compound air cylinders. The former are 12 inches by 12 inch stroke, and the latter 18 inches diameter for low pressure, 12 inches diameter for high pressure, and 12 inch stroke. The engine is of the well known Tangye frame type, mounted on a solid base, which contains a special cooler through which the air passes on its way from the low to the high pressure cylinder. In this way, its temperature is reduced to about that of running water, and the work required to compress a given volume of air is considerably reduced. A section of the air cylinder of this machine is shown by (Fig. 1). It will be seen that the cylinders are jacketed all around and in the heads, by which arrangement the air is cooled and the working parts kept at a low temperature.

Adjustable cut-offs are used for the steam cylinders, with a range of from $\frac{1}{4}$ to $\frac{3}{4}$ cut-off, while an automatic regulator, which is attached to the air receiver or reservoir, maintains a constant air pressure, cutting off the steam supply or opening up to a greater or less extent, as the air pressure runs up or drops below the set pressure. In this case the compressor regulates to within 1 to $1\frac{1}{2}$ lbs., when set to 100 lbs.

In Group IV, Civil Engineering and Transportation, the Ingersoll-Sergeant Co. also exhibited a small motor-driven compressor and some interesting models. This compressor has a

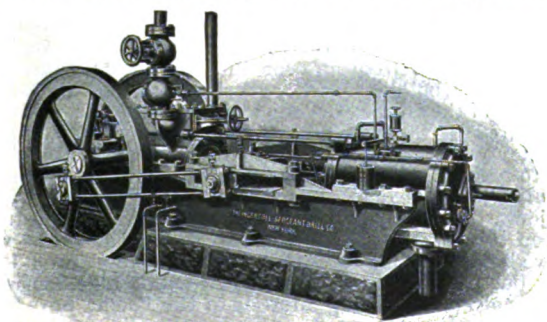


FIG. 2. INGERSOLL-SERGEANT CLASS "A" AIR COMPRESSOR.

single air cylinder, 6 by 6 inches. It has on its base a 5 H. P. General Electric Company's direct current motor, to which it is geared with a single reduction. When running at full speed, about 150 revolutions per minute, it has a capacity of 26 cu. ft. per minute, to a pressure of 50 lbs. per square inch. This machine was installed by the U. S. Commission to furnish air for operating models of the machinery used in the excavation of the Chicago

Drainage Canal, which are here shown. Among these machines are found four little working models made to $\frac{1}{4}$ scale, and illustrating in a most pleasing way the construction of a Bar Channeler, a Track Channeler, both being machines for cutting out work in quarries, canals or railway cuts, and also showing a standard rock drill and one of the company's Class "A" compressors. (Fig. 2.)

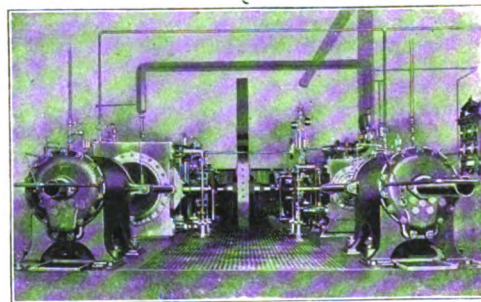
There is, in addition, a full sized pneumatic or compressed air coal cutter, such as is coming into extensive use in the United States, and an interesting series of photographs showing other apparatus manufactured by this concern. The main exhibit is,

however, at Vincennes, where it occupies a space 41 by 34 $\frac{1}{2}$ ft., or about 1,400 sq. ft., in a prominent position. Here it has two compressors and all of its mining and quarrying apparatus in the form of rock drills, coal cutters, and channeling apparatus.

The largest compressor (Fig. 3) occupying one side, is a horizontal-cross-compound Corliss type, with steam cylinders 12 and 22 inches and a 30 inch stroke. The low pressure air cylinder is 16 $\frac{1}{2}$ $\times$ 30 inches, and the high pressure 10 $\frac{1}{2}$ $\times$ 30 inches. Between them is placed a Sergeant Vertical Inter-cooler. This device effectually removes the heat resulting from compression in the first cylinder, and at the same time acts as a receiver or reservoir from which the high pressure

cylinder draws. The low pressure cylinder has an exceedingly novel and satisfactory form of inlet and discharge valve devised by Mr. H. S. Sergeant, the engineer of the company. This is a type of mechanical valve which avoids the difficulties inherent with air compressor valves which have rigid rod connections, and it depends upon compressed air for its operation. In this way, a perfect adjustment can be obtained, and cards taken from the cylinder are as regular as those obtained from a well adjusted Corliss steam cylinder.

The high pressure steam cylinder is provided with the well known Sergeant system of piston inlet valves. This type, has a higher volumetric efficiency than any other form of compressor cylinder, owing to the remarkably small clearance volume necessary, and to the large valve openings and the rapid opening and closing of valves resulting from the peculiar construction of the valves themselves. The piston is hollow and has a hollow extension at the back end, which passes out through a suitable stuffing box in the head of the cylinder. The piston, has in either face, a circular slot concentric with the piston rod. These slots are closed by a ring, which, in a cross section, resembles a letter "T." No springs are needed to open or close these valves, as the inertia resulting from the movement of the piston throws them open or closed at the proper moment. It will be seen that this form of valve admits of a remarkably small clearance. In addition, the constant inrush of cold air always passing in one direction helps to prevent excessive heating of the piston, while the water jacketed cylinder and heads hold their temperature down to a low point.



NO. 3. INGERSOLL-SERGEANT CLASS "C" COMPRESSOR.

single air cylinder, 6 by 6 inches. It has on its base a 5 H. P. General Electric Company's direct current motor, to which it is geared with a single reduction. When running at full speed, about 150 revolutions per minute, it has a capacity of 26 cu. ft. per minute, to a pressure of 50 lbs. per square inch. This machine was installed by the U. S. Commission to furnish air for operating models of the machinery used in the excavation of the Chicago

Both compressors discharge into a receiver which resembles the inter-cooler already described. This again reduces the temperature of the air to that of running water, and, as a result, precipitates nearly all of the moisture contained in the air.

From this reservoir, a 4 inch pipe line is run straight away for over 900 feet to the Palace of Civil Engineering and Transportation. The air supplied by this line runs two Baldwin locomotives, the New York Air Brake Company's exhibit, that of the Westinghouse Air Brake Co., Westinghouse Signal System, the Standard Signal System, and other exhibits.

A second and smaller line runs the entire length of the Machinery Annex Building, which taps off to the Q. & C. Pneumatic Tool Co., the Standard Pneumatic Tool Co., the Chicago Pneumatic Tool Co., the Jeffrey Manufacturing Co., the Ball Engine Co., and the Bullock Diamond Drill Co.

Both compressors take steam at from 100 to 120 lbs. and furnish air at from 100 to 105 lbs., the two machines having a volume of about 1,000 cubic feet of free air per minute.

It is interesting to note that the compressors of this company were the first apparatus in the entire American machinery section to operate on "Opening Day," April 14th, excepting the boilers installed by the Commission. They were also among the very first steam engines in the entire Paris Exposition to run with steam from the Administration mains.

Coming now to the mining machinery exhibited by this company, we first notice a large Track Channeler; in other words, a machine running on a track and intended for cutting a long, narrow vertical slot in rock of any sort. Thirty-five of these were used on the Chicago Drainage Canal, where for miles they cut vertically through hard or uncertain rock to a depth of from 24 to 36 ft. in three steps of 12 ft. each. This machine consists of a fair sized vertical tubular boiler mounted on a heavy frame, in turn supported by four flanged wheels, which run on a track made in sections. At one side and supported on a substantial bracket frame are the cylinder guides, valves and controlling mechanism. Steam passes over from the boiler through flexible connections to the cylinder and causes the piston to reciprocate, rapidly raising and driving down the cutting bars which are clamped to the guide chuck on the end of the piston rod.

The cutting points are under absolute control of the operator, who can strike hard, rapid blows or light slow ones, or he can cause the cutting to occur at the upper or lower part of the stroke. The single lever which shifts the machine along the track is also within easy reach, as are also all the lubricators, adjustments, etc. Machines of this type and make have cut as much as 375 square feet in 10 hours, although the average on large work is from 160 to 175 square feet for the same time.

Another interesting machine intended for quarries and places where the output would not warrant the expense of the large machine just described, is the Bar Channeler (Fig. 4). Briefly, it consists of a frame mounted on four adjustable legs. This frame has two long cylindrical slides, on which are mounted a carriage holding a powerful air or steam drill and a small engine which feeds the carriage back and forth along the frame. In operation, the machine is set up, the frame given the desired inclination, which may be varied from vertical through all angles to horizontal, and the drill and shifting mechanism is started. This combination of rapid and powerful blows from the cutting points, and the side movement of the feed result in a narrow slot the length of the frame and $7\frac{1}{2}$ feet deep, which is so smooth, that stone cut this way needs only facing to be ready for use in buildings or for other purposes.

The Standard Rock Drills, of which the company has several of the small and medium sizes set up for operation, are mounted on the Sergeant Universal Tripod, which permits a rapid adjustment in any direction and which, while exceedingly light in weight, is unusually rigid owing to the method of construction and clamping of the parts. Other forms of mountings, for shafts and tunnels are also shown. This company yearly produces over 2,500 of these drills, of different sizes, and it has already sold over 30,000 drills of all sorts.

A Pneumatic Coal Cutter, of which the company is turning out about 1,000 each year, and a type which is a novelty in Europe, is also shown. In a general way, this machine may be compared with a wheelbarrow, from the front of which projects the cutting tool. The operator holds the handles and guides the machine forward or from side to side, and thus cuts under the coal, which is then broken down. The claims for this type are many, and not the least important of these are its extreme simplicity, rapid and large output, the introduction of an appreciable amount of clean fresh air into the heading and the absence of powdering, which always results from the use of milling or saw cutters. Also the machine is very compact and light, and is inexpensive.

A variety of small parts, such as drills, drill sharpening tools, cutters, clamps, hoses, etc., complete this exhibit, which, as already stated, is the most extensive mining and air compressor exhibit from the United States, if not from any country exhibiting at the Paris Exposition.

Ocean Lumber Rafts.

The announcement that an immense pile raft is now under construction on Puget Sound to be towed to Japan serves to call attention to one of the most interesting industries on the Pacific coast, and one in which the shipping interests are directly interested. The rafts constructed by Capt. H. R. Robertson on the Columbia River and Puget Sound during the past year or two are not only the largest of the kind ever built, but are in many respects of unique construction. Capt. Robertson some fifteen

years ago commenced the building of these rafts on the Atlantic coast, but learning of the immense quantity of piles on the Pacific coast decided to transfer his operations, and has lately established a permanent raft building plant at West Seattle, Wash. It is anticipated that henceforth three or four rafts of the largest size will be turned out each year.

The average raft constructed by this company is 625 feet in length, 55 feet beam, 38 feet depth and 24 feet draught of water. The hull and cargo of each comprises some 11,000 piles and upwards. These raft structures have all the appearance of a whaleback, being pointed at each end, with a hull outlined and built to buffet the heaviest seas with the safety of a sailing vessel. Indeed the builders claim that if fitted with rudder and canvas they could make very fair progress on their

own account. The 11,000 piles which are worked into a raft of this kind average 60 feet each in length and the huge structure thus contains in the neighborhood of 660,000 lineal feet or about eleven times the pile cargo of a fair-sized sailing vessel.

The fact that one of these immense rafts may be taken to its destination with average safety and without the expense of employees beyond those on the towing steamer is an additional point in their favor from an economic standpoint.—Indeed the only expense in building and marketing the raft is found in the first cost of the cradle; the services of about a dozen employees being required for three months, the time ordinarily required for construction; and the outlay for some 5,000 feet of chain which is utilized to hold the piles together in their original form. The cost of the entire structure including the cradle, does not exceed \$5,000. The majority of the rafts which have heretofore been constructed have been towed to San Francisco and sold. The prices which they have brought would seem to insure an immense profit for the builders, but possibly the figures are not unduly high considering the risk involved. Shipping interests in the Pacific have carried on some agitation against these immense rafts on the ground that the piles if broken up and scattered in a storm would prove a serious menace to navigation, but no active steps have been taken to restrict their construction. The raft builders, on the other hand, declare that they have taken precautions to reduce the danger to a minimum. The chains wrapping the bulk are two inches in diameter, and in addition to being placed only six feet apart from end to end are interwoven and bound in the staunchest possible manner, so that nothing but the severest storm could possibly disrupt the mass.—*Marine Engineering*, September, 1900.

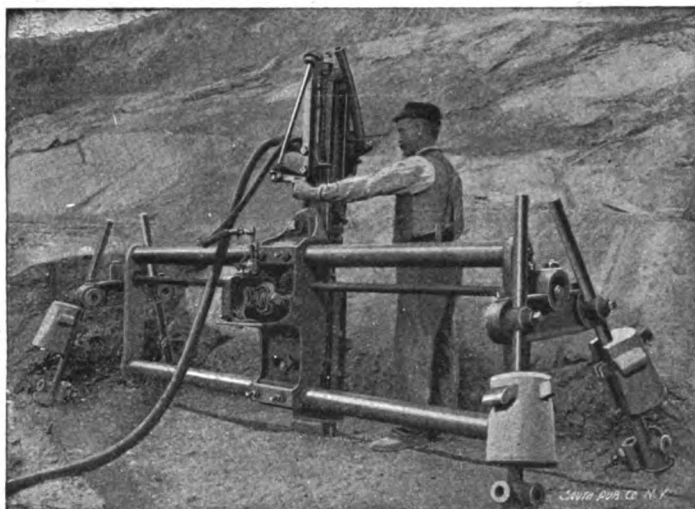


FIG. 4. STARTING A QUARRY WITH A BAR CHANNELER.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Mine Foremen's Examination for the 3rd and 4th Anthracite Districts of Pennsylvania, June, 1900.

QUES. 1.—Give name, age, place of birth and post-office address.

QUES. 2.—Give a brief description of your service in the anthracite mines. Name the mines and give length of time employed in each.

QUES. 3.—What are the requirements of the Mine Law regarding the examinations of mines?

ANS.—Rules 4, 5 and 6 of Article XII of the Anthracite Mine Law of Pennsylvania read as follows:

RULE 4.—All accessible parts of an abandoned portion of a mine in which explosive gases have been found shall be carefully examined by the mine foreman or his assistants at least once a week and all danger found existing therein shall be immediately removed. A report of said examination shall be recorded in a book kept at the colliery for that purpose and signed by the person making the same.

RULE 5.—In mines generating explosive gases, the mine foreman or his assistant shall make a careful examination every morning of all working places and travelling roads, and all other places which might endanger the safety of the workmen, before the workmen shall enter the mine, and such examination shall be made with a safety-lamp within three (3) hours at most before time for commencing work, and a workman shall not enter the mine or his working place until the said mine or part thereof, and working place are reported to be safe. Every report shall be recorded without delay in a book which shall be kept at the colliery for the purpose and shall be signed by the person making the examination.

RULE 6.—The person who makes said examination shall establish proof of the same by marking plainly the date thereof at the face of each working place and all other places examined.

QUES. 4.—What is the maximum pitch up which you would work breasts with roads, and what methods would you adopt in steeper pitches? Give a full description.

ANS.—When the pitch of the seam is from 5° to 10°, the car may be taken to the face and loaded by driving the rooms across the pitch, or at an angle with the level or gangway. This reduces the grade of the track in the rooms. When the inclination of the seam is still greater, buggies are sometimes used, the track being built upon the refuse of the seam and raised at its lower end, where a dump is arranged by which the coal is dumped from the buggy

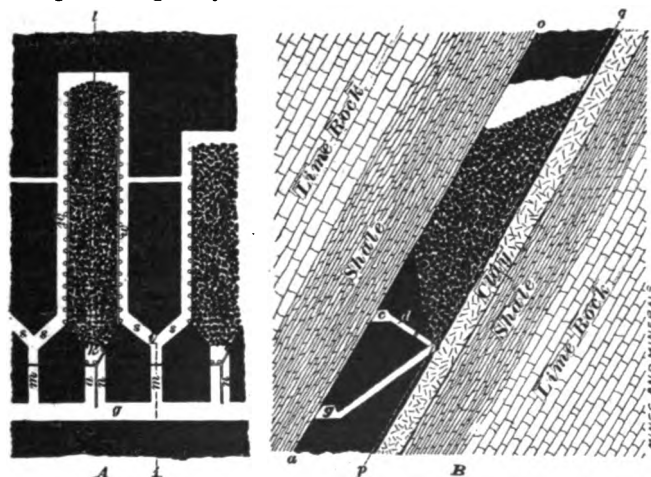


FIG. 1.

into the mine car ready to receive it. Where the coal is soft, this method cannot be used. It is employed on pitches not exceeding 15° or 18° in thick seams.

Seams pitching more than 15° are usually worked by chutes or self-acting inclines. When the pitch is less than 30° sheet iron is usually laid in the chute as a floor, to enable the coal to slide more easily; but on inclinations of less than 20 per cent. it is usually necessary to push the coal down the chute, as it does not

slide readily. On pitches steeper than 30° sheet iron is not necessary, as the coal will slide without it. Fig. 1 shows, in plan A and section B, an arrangement of the breasts, chutes, and manways, and the position of the gangway and air-course at the roof of the seam, in thick, steep-pitching beds. This position of the gangway and air-course secures a better inclination of the loading chute and manways, and presents less danger from squeeze. In the figure, *g* is the gangway and *m* the manway, dividing at the floor of the seam into two branches *s, s*, which lead to either breast. At this point, or slightly below it, a small cross-cut *d* is driven up to the airway *c*. This is bratticed off and used only in case of need, as the air is regularly conducted up one breast manway and down the other side to the highest cross-cut and thence to the next breast. Brattices with small doors are also placed in the manways to keep the air from taking a short circuit through the manways. Small manways are bratticed off the side of each loading chute for the use of the loaders.

Self-acting inclines are used sometimes upon steep pitches in preference to chutes. In this case, gangways are usually driven to the full rise and rooms set off on the strike from these, buggies being used in the rooms to convey the coal from the face to the incline.

QUES. 5.—At what points in a colliery does the law require safety-blocks?

ANS.—Rule 50 of Article XII of the Anthracite Mine Law of Pennsylvania reads as follows:

RULE 50.—Safety-blocks or some other device for the purpose of preventing cars from falling into a shaft or running away on a slope or plane, shall be placed at or near the head of every shaft, slope, or plane, and said safety-blocks or other device must be maintained in good working order.

QUES. 6.—Give name and composition of the dangerous gases of coal mines, and state the conditions under which the presence of the various gases may be expected, and how may each be detected.

ANS.—All gases in mine workings are dangerous when allowed to accumulate to any considerable amount. The gases commonly occurring in mines are: marsh gas or light carburetted hydrogen (CH_4), carbonic acid gas or blackdamp (CO_2), carbonic oxide gas or whitedamp (CO), sulphureted hydrogen gas or stinkdamp (H_2S). (These gases are fully described in the article "Mine Gases, Their Occurrence, Properties and Effects," page 275, MINES AND MINERALS, January, 1900.)

The conditions which give rise to the presence of marsh gas are always found in the working of a gaseous seam of coal; in the exposure of a large amount of fresh coal at the working face, or a heavy fall of roof, which may liberate a large amount of gas contained in the roof strata; also in the presence of feeders, or pockets of gas in the coal seam itself or the contiguous strata.

The presence of carbonic acid gas may be expected in dip workings or low portions of a large mine where there is a considerable extent of abandoned workings. This gas being heavier than air will always accumulate in the lower workings and passageways of mines where the ventilation is at all sluggish.

The presence of carbonic oxide gas may be expected in connection with abandoned workings, or the workings of mines where the ventilation is insufficient. The formation of this gas is due largely to the slow combustion of the slack and fine coal in the waste places of the mine where there is a limited supply of air.

The presence of sulphureted hydrogen gas may be expected in the working of coal seams containing a considerable amount of iron pyrites. The decomposition of the pyrites results in the formation of this gas. The gas is liable to occur frequently in the underlying strata and clays of coal seams containing pyrites.

The detection of marsh gas is accomplished by observing the effects of the gas upon the flame of a safety lamp. Usually the flame of the lamp is first lowered to a small, uniform size. The lamp is then cautiously lifted toward the roof to where an accumulation of gas is suspected and the flame carefully watched for the first appearance of a flame cap. In the presence of a small percentage of marsh gas the flame of the lamp is surmounted by a light blue flame cap. When a larger percentage of gas is present this cap is extended, and the height of the cap is always an indication of the percentage of gas present in the mixture. When the mixture approaches the explosive limit the flame is very much enlarged, and in the use of the normal lamp flame for testing the flame here becomes of a waving spindle shape. Beyond this point any increase of gas is followed by sharp cracklings and snappings of the flame, and slight explosions in the lamp.

The presence of carbonic acid gas is indicated by the dimness of the lamps, and the total extinguishing of the flame when a sufficient amount of this gas is present.

In carbonic oxide gas the lamp continues to burn brightly, the flame of the lamp, however, is lengthened and reaches upward in a slim, tapering blaze, often surmounted by a bluish tip, which is, however, difficult to observe on account of the luminous body of the flame.

Sulphureted hydrogen gas is detected by its strong smell, which resembles that of rotten eggs, from which it has received the name stinkdamp, by miners.

Ques. 7.—How would you proceed to remove a body of CH_4 from a series of breasts having a pitch of 30° , which had been filled with the gas during a stoppage of the fan?

Ans.—This question is fully answered in reply to Ques. 589, page 25, MINES AND MINERALS, August, 1900. See, also, article, "Removing a Body of Gas From Mine Workings," page 88, MINES AND MINERALS, September, 1900; and Ques. 8, page 377, March, 1900.

Ques. 8.—If you had your choice of the following intake airways, one 10 ft. $\times$ 10 ft., one 5 ft. $\times$ 20 ft., or two 5 ft. $\times$ 10 ft., which would you prefer, and why?

Ans.—The airway that would pass the largest quantity of air with the same expenditure of power would be preferable. The expression for the quantity of air passing in any given airway

under a given power is $q = a\sqrt{\frac{u}{ks}}$. Now, assuming the power and the length of the airways to be the same in each case, the quantity of air in circulation will vary as the expression $\frac{a}{\sqrt{s}}$, in

which a is the area (sq. ft.), and s the perimeter (ft.) of any airway. Substituting the given values, in each case, in this expression, we have for the relative quantities of air in circulation:

10 ft. $\times$ 10 ft. airway, q varies as $\frac{10 \times 10}{\sqrt{2(10+10)}} = \frac{100}{\sqrt{40}} = 29.24$ cu. ft.,

5 ft. $\times$ 20 ft. airway, q varies as $\frac{5 \times 20}{\sqrt{2(5+20)}} = \frac{100}{\sqrt{50}} = 27.14$ cu. ft.,

5 ft. $\times$ 10 ft. airways, q varies as $\frac{2 \times 5 \times 10}{\sqrt{2 \times 2(5+10)}} = \frac{100}{\sqrt{60}} = 25.54$ cu. ft.

The first of these airways will therefore give the largest quantity of air for the same power, and for this reason would be the one to be preferred.

Ques. 9.—In an airway 9 feet wide at the top, 12 feet at the bottom, and 9 feet high, the air having a velocity of 300 feet per minute, what quantity of air is passing per minute?

Ans. $q = av = \frac{9(9+12)}{2} \times 300 = 94.5 \times 300 = 28,350$ cu. ft. per minute.

Ques. 10.—What is meant by the terms ventilating pressure, water gauge, and resistance of air?

Ans.—The term *ventilating pressure* refers to the pressure producing ventilation. This is the total pressure upon the airway as indicated by the expression pa . The *unit of ventilating pressure*, or the pressure per square foot of area, producing ventilation, is, however, often spoken of as the ventilating pressure, in which case pa is the *total pressure*. [The ventilating pressure (pa) is always equal to the resistance of the mine or airway, since it is this resistance that causes the pressure.]

The water gauge is a glass tube bent in the form of the letter U and having two open ends. Water is placed in the bend of the tube, and one of the open ends is extended and bent over so as to pass through a hole in a door or brattice to which the instrument is attached in the mine. A small hole is bored in a door or brattice located between airways in which there is a difference of ventilating pressure. The two ends are thus subject to different pressures, the pressure upon the intake always being greater than that upon the return airway. This causes the water to sink in the arm of the water gauge open to the intake, and to rise a corresponding amount in the other arm. This difference of level is read from the scale on the face of the gauge and the term "water gauge" is frequently applied to this reading. [The use of the *water gauge* has been fully described in reply to Ques. 30, Page 273, MINES AND MINERALS, January, 1900.]

The term *resistance* as applied to the circulation of air in an airway, refers to the friction developed by the passing of the air current through the airway. The rubbing of the air upon the sides, top, and bottom, of the airway causes friction which produces a certain resistance to the passage of the current. [This resistance is therefore proportional to the extent of the rubbing surfaces. It also depends upon the velocity of the current, being proportional to the square of that velocity. This is true, because when the velocity is doubled, the same quantity of air touches twice the amount of rubbing surface, or meets with twice the number of resisting particles, and strikes each particle with double the force; hence, the resistance offered when the velocity is doubled is $2 \times 2 = 4$ times the original resistance. The unit of resistance is the amount of resistance (lb.) offered by one square foot of rubbing surface to a current having a velocity of one foot per minute. The total resistance is therefore obtained by multiplying the unit resistance (k) by the number of square feet of rubbing

surface (s), and that product by the square of the velocity (v^2). The total resistance, as mentioned above, is equal to the ventilating pressure, or the total pressure upon the airway (pa). Hence, for the total resistance we write $R = pa = ks v^2$.]

Ques. 11.—If the water gauge shows a depression of $\frac{1}{2}$ inch what is the velocity of air per minute when a cubic foot of air weighs .076 pound?

Ans.—The head of air column (h) in feet, corresponding to a given water gauge (i) in inches, calling the weight of one cubic foot of air w , is determined as follows:

$$h = \frac{5.2 \times i}{w} = \frac{5.2 \times \frac{1}{2}}{.076} = 34.21 \text{ ft.}$$

The theoretical velocity due to this head of air column is given by the expression $v = \sqrt{2gh} = \sqrt{2 \times 32.16 \times 34.2} = 46.91$ ft. per sec. This is not, however, the velocity of the airway due to this pressure. The theoretical velocity means simply the velocity due to a certain height, where no resistance is encountered. The actual velocity in the airway due to any pressure, is always less than the theoretical velocity due to the same pressure, and depends upon the resisting power of the airway. [This theoretical velocity is the same velocity as a body will acquire in falling through the height h , in a vacuum. In the circulation of fluids this height h is called the *pressure head*, and the theoretical velocity of the flow (ft. per sec.) is given by the expression $v = \sqrt{2gh}$. The pressure head (in air, head-of-air-column), is always found by dividing the unit pressure, or pressure per unit of area, (p), by the weight of one cubic foot of the flowing medium.]

Ques. 12.—If, at 80 revolutions of the fan, a water gauge of 2 inches and 150,000 cubic feet of air are produced, what would be the water gauge and quantity of air at 50 revolutions?

Ans.—It is customary to assume roughly that the quantity of air in circulation is proportional to the speed of the fan, for any given fan and airway, and the pressure to vary as the square of this speed, which will give as follows: For the quantity, 80 : 50 :: 150,000 : x , or $x = 93,750$ cu. ft. per min.; for the water gauge, $80^2 : 50^2 :: 2 : x$, or $x = \frac{5}{4}$ inch of water gauge.

[In practice, however, this proportion does not hold true, but the quantity varies more accurately as the fifth root of the fourth

power of the speed; or, in this case, as $\sqrt[5]{\left(\frac{5}{8}\right)^4} = .6866$; and $150,000 \times .6866 = 102,990$ cu. ft. per min. In like manner, since the pressure varies as the square of the quantity, it will vary in

this case as $\sqrt[5]{\left(\frac{5}{8}\right)^8} = .4714$; and $2 \times .4714 = .9428$ inches of water gauge.]

Ques. 13.—If it becomes necessary to stop a fan for repairs, how would you keep the mine clear of gas in the meantime? What precaution should be taken before stopping the fan?

Ans.—A steam jet or blower should be arranged at the foot of the upcast shaft, or if this is not sufficient, a temporary furnace may be constructed at the foot of the upcast shaft, taking ample precautions to avoid any risk of fire by making the furnace very small, and protecting the same as much as possible. Or, a fire basket may be hung in the upcast shaft; the basket should be suspended or hung as near to the bottom as possible. If the pumps are in good working order, and a plentiful supply of water is at hand, the ventilating current may be assisted by arranging a fall of water in the downcast shaft. The fall of water should be arranged, as far as possible, on the principle of the trompe, and so as to cover the entire area of the shaft. Advantage should also be taken, at the top of the downcast shaft, to catch all the wind that is blowing at the surface, by the erection of a temporary sail or wind cowl.

In case of accident to the ventilating fan at any mine, or the stoppage of the fan for any cause whatsoever, it would be the duty of the mine foreman to notify the men in the mine, and if necessary, to promptly withdraw all the men from the mine workings. [This is made compulsory by the mine law in the Bituminous districts of Pennsylvania.]

Ques. 14.—If with a water gauge of 2 inches, 150,000 cubic feet of air is circulating, what would be the volume of air with a water gauge of 1.64 inches?

Ans.—The volume of air in circulation varies as the square root of the pressure, or as the square root of the inches of water gauge. Hence, the $\sqrt{2} : \sqrt{1.64} :: 150,000 : x$, and $x = \sqrt{\frac{1.64}{2}} \times 150,000 = 135,828$ cu. ft.

Ques. 15.—An airway 8 ft. $\times$ 12 ft. and 4,000 feet long, has 28,800 cubic feet of air, what is the rubbing surface, pressure and horsepower?

Ans.—The rubbing surface is determined as follows: $s = 2(8+12) \times 4,000 = 160,000$ sq. ft. The pressure per square

$$\text{foot, } p = \frac{k s q^2}{a^3} = \frac{.000000217 \times 160,000 \times 28,800^2}{(8 \times 12)^3} = 3.255 \text{ lb.}$$

$$\text{The horsepower, h. p.} = \frac{28,800 \times 3.255}{33,000} = 2.84 \text{ h. p.}$$

Ques. 16.—What are the essential parts of a safety lamp?

Ans.—The essential parts of a safety lamp are: the oil vessel, the gauze or gauzes, the glass cylinder, the bonnet, the inner chimney of the Meuseler lamp, the various forms of deflectors where used, and the port holes for the entry of air into the lamp, together with the frame or standards that bind the different parts together, and the lock which prevents the untimely opening of the lamp.

Ques. 17.—What are the best precautions against explosions of gas, and fires in mines?

Ans.—The best precaution to be taken against the explosion of gas, and fires resulting therefrom, is the maintaining of an ample air current in circulation in the mine, and causing this current to sweep the entire working face of the mine, also the thorough ventilation of the abandoned portions of a gaseous mine. The daily and regular examination of all the working places of a mine by the fire boss, to ascertain that the air current is passing properly and in sufficient quantity through the airways and working places, and that the timbering is sufficient to prevent falls of roof, whereby large quantities of gas are often liberated. A standard mercurial barometer should also be located at the mouth of every gaseous mine, and the variations of the atmosphere carefully observed each hour of the day. Any sudden change in barometric pressure should be reported at once to the mine foreman, and extra precautions taken to prevent a dangerous increase of the percentage of gas in the air current. Precautions should also be taken against the accidental ignition of gas feeders, from the flame of a blast, which has often given rise to serious fires in mine workings. Gas feeders in the floor often become ignited in this way, and draw back under the gob or waste, and burn for days. These burning feeders should be extinguished as soon as they are detected. This may often be done by the explosion of a small amount of dynamite in the vicinity of the burning gas, the concussion of the explosion extinguishing the flame. Mine fires resulting from spontaneous combustion, in the gob and waste places of a mine, should be particularly guarded against, and every means used to extinguish such fires when discovered. This class of gob fires is best prevented by taking the precaution of loading out the "fines" or coal slack, instead of storing the same in the gob.

Blasting in dusty mines or in gaseous workings should only be allowed after a thorough examination of the working face in the vicinity of a shot. Every shot should also be examined by an authorized person who has the power to condemn and prevent the firing of any shot that, in his opinion, is unsafe. The working face in the vicinity of the blast should always be free from accumulations of gas and fine dust, and where the coal is particularly soft and gaseous the immediate vicinity of the blast should be sprinkled before a shot is fired.

Ques. 18.—Explain the symbols CH_4 , CO_2 , SH_2 , and what are their comparative weights?

Ans.—The symbol CH_4 is the symbol of carburetted hydrogen or marsh gas. Each molecule of this gas consists of one atom of carbon chemically united to 4 atoms of hydrogen. The carbon is represented by the symbol C , and the hydrogen by the symbol H , the number of atoms being indicated by the small subscript letter following the symbol.

The symbol CO_2 stands for carbonic acid gas. Each molecule of this gas consists of one atom of carbon chemically united to two atoms of oxygen; the symbol for oxygen being O . The symbol SH_2 , or as it is more usually written, H_2S , stands for sulphuretted hydrogen gas; each molecule of this gas consists of two atoms of hydrogen chemically united to one atom of sulphur; the symbol of sulphur being S .

The molecular or comparative weights of these gases are as follows: CH_4 , 16; CO_2 , 44; H_2S , 34.

Ques. 19.—Explain the safest and most effective way of circulating air through mines.

Ans.—The safest and most effectual method for the ventilation of mine workings is that in which the main air current is divided into two or more splits, as near as practicable to the bottom of the downcast, each of these splits being employed for the ventilation of separate districts of the mine. These splits, which are known as *primary splits*, should be again divided into other or *secondary splits*, at any point of the mine in which such division can be accomplished to advantage. By this means each district of the mine is provided with its own circulation and receives purer air, inasmuch as the return air from any district in the mine is not conducted around the working face of any other district; but passes directly into the main return airway, and thence to the bottom of the upcast shaft. Any

derangement of the current in one district does not necessarily affect the circulation in other districts of the mine. If for any reason a larger quantity of air than usual is required at any one point in the mine, this can be accomplished readily in this method by reducing the quantity of air in any one or in all of the other splits. This is an unquestioned advantage, especially in the ventilation of gaseous mines, and as we say, the ventilation by this means is more readily controlled.

Ques. 20.—A slope is $4\frac{1}{8}$ inches on the mine map, the tidal elevation of the top is 780 feet, at the bottom of the tidal elevation is 530 feet, what is the length and grade of the slope?

Ans.—Assuming that the mine map is drawn to the usual scale of 100 feet to the inch, 4.6 inches upon the mine map corresponds to a distance of $4.6 \times 100 = 460$ feet. This is the horizontal length of the slope. The rise of the slope is $780 - 530 = 250$ feet. The tangent of the slope angle is $\frac{250}{460} = .54348$; and the angle of the inclination of the slope is therefore $28^\circ 31'$; the grade of the slope is 1 : 1.84, or one foot of rise in 1.84 feet horizontal distance, or 5.43 per cent.

$$\text{The length of the slope is } \frac{460}{\cos. 28^\circ 31'} = \frac{460}{.8787} = 523.5 \text{ ft.}$$

Ques. 21.—A breast is 400 feet long, on map it is 3.76 inches, what is the vertical height at face from level of gangway?

Ans.—Assuming, as in the last example, the scale of the map to be 100 feet to the inch, the horizontal length of the breast would be $3.76 \times 100 = 376$ feet. The length measured upon the pitch being 400 feet, the vertical height or the rise at the face of the breast would be $\sqrt{400^2 - 376^2} = 136.5$ feet. Or, we may first find the pitch angle thus, $\frac{376}{400} = .94$ is the cosine of the pitch angle. Hence, the angle $= 19^\circ 57'$. Then, $400 \times \sin 19^\circ 57' = 400 \times .3412 = 136.48$ feet, length of breast measured on the pitch.

Ques. 22.—The gangway is driven N 50° E, the breasts N 10° W, the pillars are 30 feet wide, and breasts are 24 feet wide, what is the distance between center line of breasts on the gangway?

Ans.—The angle between the gangway and the breast is found in this case by adding the angles of the respective bearings of the gangway and breast. Thus, $10^\circ + 50^\circ = 60^\circ$. Then $\frac{30 + 24}{\sin 60^\circ} = \frac{54}{.866} = 62.36$ feet, distance between center lines of breasts measured on the gangway.

Ques. 23.—Describe the conditions requiring that a mine be worked by locked safety lamps, and what provisions should be made to have extinguished lamps relighted.

Ans.—Locked safety lamps should be employed in any mine generating or known to have generated explosive gas, in order to ensure absolute security against explosion. This requirement, however, is not put into practice as stringently as safety would often require. Many mines while generating explosive gas yield this gas in such small quantities and so regularly as not to present the dangerous conditions that would demand the use of locked safety lamps. Other mines generate larger quantities of explosive gas for a given time, after which the quantity of gas given off at the face decreases and the use of locked safety lamps is often abandoned, in such cases. Still other mines in the immediate neighborhood of gaseous workings give off but little gas, and seem not to require the continuous use of safety lamps. All of these mines present conditions that would demand the use of locked safety lamps in order to guarantee absolute security against explosion, but inasmuch as the use of the safety lamp is to an extent a hindrance to his work, the miner is prone to expose himself to considerable risk in this regard; and very much prefers to use a naked light, except where the conditions are manifestly present demanding the use of safety lamps only.

Rule 9, Art. 12, of the Anthracite Mine Law of Pennsylvania reads as follows:

"In every working approaching any place where there is likely to be an accumulation of explosive gases, or in any working in which danger is imminent from explosive gases, no light or fire other than a locked safety lamp shall be allowed or used."

The law therefore requires the use of locked safety lamps in workings approaching abandoned workings, as gas may be suspected, or in workings where dangerous accumulations of gas are liable to occur.

A lamp station should be located upon the intake airway at a point as far inbye as practicable, and free from any danger from explosive gases. This lamp station should be in charge of a duly authorized person who should examine and relight any lamp brought to him for that purpose. Where such a lamp station is not maintained in the mine, all lamps which are extinguished by accident should be sent to the surface for relighting, unless the lamp contains an internal relighter.

Ques. 24.—Describe the best method for hauling coal, by mules, out of a gangway 5,000 feet long, and best grade for the track.

Ans.—The best method for haulage by mules, in such a case, would be to provide partings or turn-outs at suitable distances along the haulage road. This distance for a regular output of say from 500 to 800 tons per day, may vary from 200 to 300 yards in length. One or two drivers may be employed upon each stretch, or between each of the consecutive partings. Two drivers are preferable since they can assist each other in case of difficulty from the derailment of cars, etc., and where the grades are suitable they should follow each other instead of alternating trips. Where there are steep grades upon the haulage road, however, the second driver should not follow the first too closely.

The best grade for the haulage road would be a slight grade in favor of the loaded cars. This grade should not exceed say 3%, a 2% grade being preferable.

Ques. 25.—What kind of haulage would you recommend in place of mules, and why?

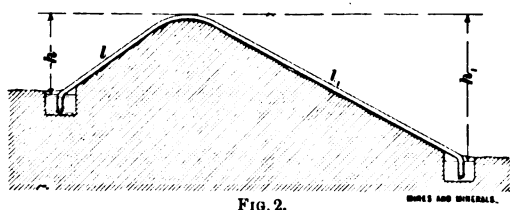
Ans.—Mule haulage should be replaced by rope haulage, or motor haulage by compressed air, electric or gasoline motors, as early as the development of the mine admits, for the reason that excepting for very small mines rope or motor haulage is cheaper and much more efficient than mules. Neither do they vitiate the mine air as do mules. [The comparative advantages and disadvantages of compressed air and electricity are enumerated in answer to Ques. 567, Page 457, MINES AND MINERALS, May, 1900. See also, answer to Ques. 27, Page 472, May, 1900; and article, Haulage, page 520, June 1900.]

Ques. 26.—What conditions are required for the successful operation of a siphon?

Ans.—The conditions required for the successful operation of a siphon may be stated as follows:

(1) The height of the summit of the siphon above the surface of the water in the upper basin, or the vertical lift of the siphon, must not exceed a practical limit to which the atmosphere will force the water. This height theoretically is 34 feet, at sea level, and decreases as we ascend above the level of the sea. A safe rule to apply in determining the vertical height to which the atmosphere will force the water in the suction pipe of a pump, or in the short leg of a siphon, is to take .8 of the barometric height, in inches, for the vertical lift of the pump or siphon, in feet. Thus, if the barometer stands at 30", the lift of the pump or siphon may be taken as $30 \times .8 = 24$ feet. Where the suction pipe is nearly vertical, and consequently of shorter length, this height may be somewhat increased; but where the suction pipe is inclined and its length therefore considerable, the vertical lift should be decreased proportionately. [See also answer to Ques. 20, Page 188, MINES AND MINERALS, November, 1899; also article "Can a Siphon Have Too Much Fall" page 474, May, 1900.]

(2) The longer leg, or the discharge pipe of the siphon, must fall through a greater vertical height than the short leg or draft pipe. In Fig. 2, the vertical height h is called the lift,



and the vertical height h_1 , the fall of the siphon. The difference between these heights ($h_1 - h$) may be called the siphon head. When the fall of the siphon (h_1) exceeds the practical limit to which the atmosphere will force the water, care must be taken to arrange the fall of the siphon relative to its lift, according to

the equation $h_1 = \frac{1}{l}(34 - h) + 34$. If this is not done there is a tendency to the formation of a vacuum, at the crown of the siphon, that will cut off entirely, or reduce the flow of water in the siphon. In this case, it is often remarked that the pipe does not run full, and in many instances the flow will cease entirely after a short time. [See also Page 475, MINES AND MINERALS, May, 1900.]

Another important condition requisite to the successful operation of a siphon, is the submerging of both ends of the siphon pipe in their respective basins, in order to prevent air being drawn into the pipe, and reaching the crown or summit of the siphon. This takes place more readily in the short leg of the siphon than it does in the long leg, due to the direction of the flow of the water. The submergence of the discharge end of the siphon, however, is important in order to ensure a full flow in the pipe. Air which is carried into a siphon by the water will gradually

accumulate at the highest point of the siphon pipe and will interfere with the working unless a cock is provided at that point through which the air can be let off from time to time.

Ques. 27.—What maximum height should there be between a pump and the water in the sump, barometer being 30 inches?

Ans.—The rule given in the answer to the preceding question should be applied in this case. Thus, $30 \times .8 = 24$ ft. As explained previously, this height may be increased or decreased slightly, according to the position of the suction pipe and its length. The perfectness of the pump also determines to a certain extent the height which the pump will draw. With the most perfect pump and a short vertical lift, this height will rarely exceed or even equal 28 feet, when the barometric height is 30 inches.

Roadways in Inclined Seams.

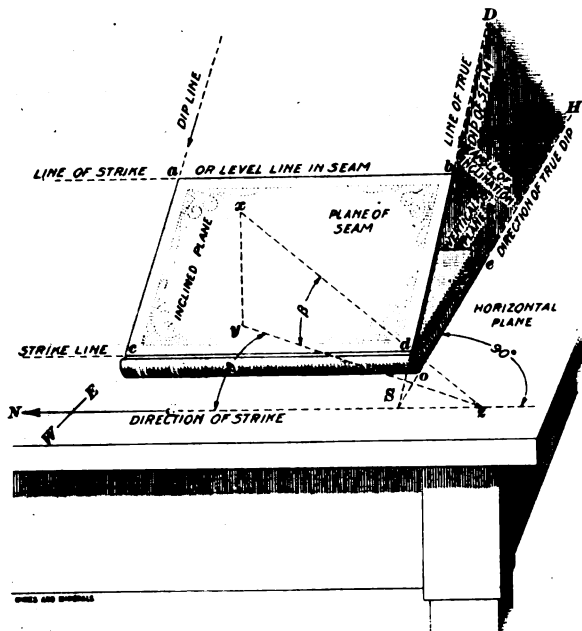
In laying out the roadways for haulage in inclined seams, advantage should always be taken of the force of gravity. The road should be given such a bearing with respect to the strike of the seam, as to furnish a slight grade in favor of the loaded cars. This will very much facilitate the movement of the loads, and decrease the expense of haulage. It is an important consideration in the economical operation of a coal seam, since whatever decreases the expense of handling the coal from the face to the tipples increases to that amount the value of the coal on the track.

A few words of explanation in regard to the dip and strike of a seam, will render the situation more clear. The term "strike," as applied to inclined seams, refers to the direction of a level line in the seam, while the term "dip of the seam" refers to the angle the plane of the seam makes with a horizontal plane. The strike of an inclined seam is thus determined by the intersection of that seam with a horizontal plane. This line of intersection will be level, since it lies in a horizontal plane; and it will be a line of strike since it is a level line in the seam. Lay a book upon the table (See figure) and partially raise one cover, so that the raised cover represents an inclined seam. The upper edge of the raised cover ab , or its lower edge cd , is parallel to the plane of the table, and both of these edges are therefore level lines. They both represent lines of strike, since they are level lines in the seam as does also the line NS in which the plane of the raised cover if extended would intersect the horizontal plane of the table. The inclined edges ac and bd , of the raised cover, in like manner represent lines of true dip, or the full dip of the seam. The angle DSH at which the cover is raised, which is the angle that the seam makes with the plane of the table, is the angle of inclination or the dip angle of the seam. This angle is often spoken of as the amount of dip of the seam; or, the amount of dip is sometimes given by stating the rise in any given horizontal distance. Thus, we may say a seam has a dip of 1 in 10, meaning that the line of true dip of this seam rises or falls one foot in every ten feet of horizontal distance. The tangent of the angle of inclination of the seam, in such case would be $\frac{1}{10} = .1$, and the angle of inclination is therefore $5^\circ 43'$ (see a table of natural tangents and cotangents).

When we speak of the bearing or direction of the strike, or of the dip of a seam, we mean the direction either of these lines may have upon the mine map with respect to the meridian, or the angle each makes with the meridian. These angles are obtained by surveying and are always horizontal angles; that is to say, they lie in a horizontal plane. When the bearing of a line is measured with an instrument in surveying, the angle is measured in the horizontal plane. If we project the inclined edge bd of the raised book cover representing the dip of the seam, upon the plane of the table, the projection, or the line SH , will indicate the direction or bearing of the dip of the seam. This direction of dip will thus be represented by the edge oe of the lower cover of the book as it lies upon the table. The angle this projected line makes with the meridian is the bearing or the direction of the true dip of the seam. It must also be remembered that while these angles of direction, or angles denoting the bearing of a strike or dip are horizontal angles, the angle of inclination of the seam is a vertical angle, and is measured in the vertical plane. This angle of inclination DSH is the angle the line of true dip makes with its projection upon the horizontal plane.

Referring to this illustration of the book lying upon the table, with its raised cover representing the plane of the seam, if a slope is driven upon the full dip of this seam, or a heading driven to the full rise of the seam, either of the inclined edges ac or bd of the book, will represent such slope or heading. Any other inclined line in this seam will represent a slant road. Thus, suppose we wish to drive a slope to the full dip of this seam. We will represent this slope by the right-hand inclined edge bd of the raised cover of the book; the upper edge ab and the lower edge cd of the book, being level lines, represent strike lines in this seam, and therefore represent levels or gangways driven upon the strike in the seam. Now, suppose from the lower right hand

corner d of the book we draw upon the raised cover any diagonal line as dx ; this line will represent a slant road in the seam. Extend this line x to intersect the plane of the table at z ; project the point x upon the same plane by a perpendicular xy and draw zy , which will be the projection of xz upon the horizontal plane of the table. The projection yz upon the horizontal plane gives the direction or bearing of the slant road xd , and the angle Nzy between this projected line and the strike line is the angle the



slant road makes with the strike of the seam. This angle is often spoken of as the angle between the slant road and the level or gangway. It is not the angle cdx or Nzx in the seam, but its projection Nzy upon the horizontal plane. The dip of the slant road, or its grade or angle of inclination, xzy will vary from zero, to an angle equal to the true dip angle, or angle of inclination of the seam. The grade of the slant road will be less as its direction approaches the direction of the gangway, and greater as its direction approaches the direction of the true dip of the seam. In the figure the strike of the seam is due north and south, and the maximum or true dip is due west.

A simple rule for determining the grade of a slant road in a seam of any inclination, when the slant road makes a given angle Nzy , with the level or strike of the seam, is as follows: The percentage of grade of the slant road is equal to the product of the sine of the angle the road makes with the strike of the seam, and 100 times the tangent of the angle of inclination of the seam. Thus, calling the angle of inclination of the seam α , and the angle the road makes with the strike of the seam θ , we have,

Percentage of grade of slant road = $100 \times \tan \alpha \times \sin \theta$, 1.
Or, if the grade of the slant road is given by its dip angle, or angle of inclination, and calling this angle β , we have,

$$\sin \theta = \frac{\tan \beta}{\tan \alpha}, \quad 2.$$

The formulas just given enable us to determine very quickly the percentage of grade of any slant road, in a seam of a given inclination; or to determine the angle that a slant road must make with the strike of a seam of a given inclination, in order to have any given rise or dip (grade).

It is to be observed that it is always possible from a given point of a level or gangway, in any inclined seam, to drive two slant roads to the rise, or two slant roads to the dip, each having the same grade. One of these two roads will be driven to the right and the other to the left of the true pitch or true dip of the seam; but each of them will make the same angle with the strike of the seam or the level or gangway.

Example.—To illustrate the use of these simple formulas, suppose it is desired to ascertain the bearing of a northwesterly slant road having a 5 per cent. grade, in a seam whose inclination is 20° , the direction of the dip of the seam being $N 4^\circ 30' W$.

Solution.—The true dip of the seam being $N 4^\circ 30' W$, the line of strike, or the line at right angles to this will be $S 85^\circ 30' W$. To find the angle that a slant road having the required grade, makes with the strike of this seam, we have,

$$\sin \theta = \frac{\tan \beta}{\tan \alpha} = \frac{.05}{\tan 20^\circ} = \frac{.05}{.364} = .13736;$$

which makes the required angle between the strike line and the

slant road $7^\circ 54'$. Hence, since the slant road is to be a northwesterly road, its bearing will be $180^\circ - (85^\circ 30' + 7^\circ 54') = 86^\circ 36'$; or bearing is $N 86^\circ 36' W$.

Example.—Suppose it is required to determine the percentage of grade of a slope or heading in this seam (inclination of seam 20° , direction of dip $N 4^\circ 30' W$), the bearing of the slope being $N 10^\circ 15' E$.

Solution.—As before the direction of strike of this seam is $S 85^\circ 30' W$, or for this case, say $N 85^\circ 30' E$. The angle that the slope makes with the direction of slope will then be $85^\circ 30' - 10^\circ 15' = 75^\circ 15'$. We have then for the percentage of grade, $100 \tan \alpha \times \sin \theta = 100 \times .364 \times \sin 75^\circ 15' = 36.4 \times .967 = 35.2$ per cent. This grade corresponds to a rise of 35.2 feet in 100 feet of horizontal distance. The angle of inclination of the slope is therefore the angle whose tangent is .352; or the angle of inclination of the slope is $19^\circ 23' 30''$.

Particular attention is called to the fact above mentioned that the bearings of lines and roadways, are the angles which the projection of these lines or roadways, upon a horizontal plane, make with a meridian line. These bearings are always measured in the horizontal plane and are therefore, horizontal angles. Angles of inclination on the other hand, are measured in a vertical plane, and are therefore vertical angles. An angle measured with an instrument is never measured in an inclined plane; the planes of the instruments must be either horizontal or vertical. For this reason, when we speak of the angle a road makes with the true dip of the seam, we mean the horizontal angle between the projection of that road upon the horizontal plane, and the projection of the true dip upon the same plane. We do not mean the angle between the roadway and the line of dip, in the seam.

Size and Shape of Airways.

The question is often asked, what is the best form and size for an airway in mine ventilation. This is an important question and calls for careful consideration, which can only be given after an intelligent understanding of the theory of conducting air currents through airways as well as a thorough experience in practical mining. When we speak of the best form and size of airways in mining, we mean that form and size of airway that will produce the best economic results with respect to the ventilation of a mine. The question is affected by considerations (1) of a theoretical nature, and (2) of a wholly practical nature. From a theoretical standpoint the best form of airway is that which will circulate the largest quantity of air with the same expenditure of power.

Power Producing Ventilation.—The simplest expression for the power producing ventilation is

$$u = k s v^3, \quad 1.$$

where u = work performed per minute (foot-pounds),

k = unit of resistance offered by one square foot of rubbing surface to a current having a velocity of one foot per minute (lb.),

s = rubbing surface of the airway (sq. ft.),

v = velocity of the air current (ft. per min.).

Writing this expression for the work performed per minute, $u = (k s v^3) \times v$, and remembering that $k s v^3$ is the expression for the resistance of the airway, we see that the above equation expresses the work necessary to produce a given velocity against a given resistance.

Substituting in equation 1 for s its value $l o$, and for v its value $\frac{q}{a}$ we obtain

$$u = \frac{k l o q^3}{a^3}, \quad 2.$$

where l = length of airway (ft.),

o = perimeter of airway (ft.),

q = quantity of air in circulation (cu. ft. per min.),

a = sectional area of airway (sq. ft.).

Equation 2 expresses the work performed in circulating a given quantity of air in a given airway, and is the equation we

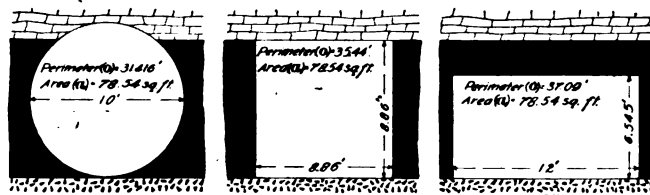


FIG. 1.

must use in determining what form of airway will yield the largest quantity of air, with the same expenditure of power.

Form of Airway That Will Circulate the Largest Quantity of Air With the Same Power.—The three typical forms of airway are shown in Fig. 1. These are the circular, square and rectangular forms.

The dimensions given, in the figure, for each airway are such as to make the areas equal. Referring to equation 2, we observe that for any given power the quantity of air circulating in airways of the same length and having the same sectional area, varies inversely as the cube root of the perimeter, or q varies inversely as $\sqrt[3]{o}$. Now, comparing the several forms of airways having equal areas, and expressing the perimeter of each of these forms in terms of the area, we have

$$\text{Circular airway; } o = 3.1416 \sqrt{\frac{a}{.7854}} = 3.5449 \sqrt{a}.$$

$$\text{Square airway; } o = 4\sqrt{a}.$$

$$\text{Rectangular airway; (calling shorter side } d, \text{ and longer side } r d, r \text{ being any ratio greater than 1), since } a = d \times r d = r d^2, d = \sqrt{\frac{a}{r}}, \text{ and } o = 2(d + r d) = 2\sqrt{r} \left(\frac{1}{r} + 1 \right) \sqrt{a}.$$

The relative perimeters and quantities are therefore as follows:
Circular airway, rel. perim. 3.5449;

$$\text{rel. quant. } \frac{1}{\sqrt[3]{3.5449}} = .6558 \text{ cu. ft.}$$

$$\text{Square airway, rel. perim. 4; rel. quant. } \frac{1}{\sqrt[3]{4}} = .63.$$

$$\text{Rectangular airway, rel. perim. } 2\sqrt{r} \left(\frac{1}{r} + 1 \right);$$

$$\text{rel. quant. } \frac{1}{\sqrt[3]{2\sqrt{r} \left(\frac{1}{r} + 1 \right)}},$$

or calling the quantity of air circulating in a circular airway of a given sectional area, with the expenditure of a given power, unity or 1, the quantity circulating in a square airway of the same area and length, with the same expenditure of power, would be .9605; and the quantity circulating in a rectangular airway whose width is twice its height ($r = 2$), the airway having the same area and length, and the power being the same, would be .9419. That is to say, for every 10,000 cubic feet of air a given power will circulate in a circular airway, the same power will circulate 9,605 cubic feet in a square airway of the same length and area; or 9,419 cubic feet in a rectangular airway of the same length and area, when the width of the airway is twice its height ($r = 2$). These comparative quantities will be of value as showing the effect of the form of the airway upon the circulation due to any given power.

Size of Airway Affects Velocity of Current.—The size of an airway is also an important consideration. This is determined by the volume of air which the airway is required to pass, since if the sectional area of the airway is too contracted for the quantity of air in circulation, the velocity resulting in the airway will be too high; and on the other hand, if the sectional area of the airway is too great the resulting velocity of the air current will be too low. The velocity in practical mine ventilation should be maintained between certain limits. If the velocity is too low, the air current does not fulfill its purpose, which is to sweep the gases from the cavities of the roof and sides of the airway where they accumulate. If the velocity is too high, it results in discomfort and annoyance to the men working upon the airway, and in gaseous mines there is danger of the flame of the safety lamp being blown through the gauze. For these reasons the practical limits of the velocity of the air current for gaseous mines is, say from 240 to 450 lineal feet per minute. In non-gaseous mines these limits may be extended from 180 to say 1,200 or 1,500 lineal feet per minute. The Anthracite Mine Law of Pennsylvania limits the velocity of the air current in mines generating explosive gases to 450 lineal feet per minute.

The same rule should be applied in ascertaining the proper size of an air shaft. The sectional area of the shaft should be estimated from the quantity of air which it is desired to circulate, but a higher velocity may be used in estimating the size of a shaft. The velocity in the shaft will at times reach as high as 3,000 lineal feet per minute.

Practical Considerations.—Aside from theoretical considerations, the form of airways is modified and largely determined by practical conditions. As we have just seen, from a theoretical point of view the circular airway is the form that presents the best conditions for economical ventilation. In practice this form of airway is rarely adopted in American mines, except in some instances where entry driving has been performed with the Stanley header. Where this machine is used in entry driving, the sectional area of the airway is a complete circle, and if the machine is followed closely with the work of lining the airway with a cylindrical lining, the circular form may be retained in the finished airway. The expense of making this form of airway secure, however, prevents its common use. A more usual form of airway is one having a semi-circular arch for a roof, the sides and

floor of the airway being cut square. This form is very common in tunnel work.

The two remaining forms of airway, the square and the rectangular airway, present conditions which are readily attained in ordinary mine work. In thick seams, airways having a cross-section which approaches more or less closely to a square are very common, while rectangular airways, having a width considerably greater than their height, are most common in thin seams. The reason for this is obvious, since the expense of brushing the roof or lifting bottom to increase the height of an airway over that afforded by the thickness of the seam is expensive, and is only resorted to in the construction of passageways where it is an absolute necessity to obtain sufficient height for mules and men. In thin seams it is usually considered an unwarranted expense to make the height of an airway greater than the thickness of the seam, except only where there is a draw slate or similar stratum, overlying the coal, that falls after the coal has been extracted. In such cases the timbering of the airway is delayed for a season until the roof stratum or draw slate has fallen, when the airway is cleaned up and timbered.

It is important to know the theoretical conditions that affect the form of airway, and to know which form produces the best economical results, in order that we may profit by such knowledge, in the adoption of such form of airway when the practical conditions will permit. These practical conditions always control the actual work of mining.

Another common form of airway is that of the trapezoid. We have not considered this form however, inasmuch as its consideration does not differ from that of rectangular airways. In any of these forms of airway the quantity of air, for the same power, and for the same length and area of airway, will vary inversely as the cube root of the perimeter. The trapezoidal form of airway will always present a slightly greater perimeter, for the same sectional area, than a rectangular form of airway; and the quantity of air passing in the former will therefore be slightly less than that passing in the latter, for the same power. The difference, however, between these two forms of airways is very small and need not be considered separately as a class.

How to Make Gold Dredging Pay.

Many men whose opinions are trustworthy on other subjects are entirely unable to form a sane or just conclusion on matters connected with gold. Many, if not most, men also are inclined to put a better face on the question than usually exists, and the sight of a few yellow colors leads them at once to figure out a bonanza. If investors would only bring to bear on gold mining the same prudence and business sense which is necessary in any other business, it would greatly reduce the number of failures. The investor has to guard against two classes of evil advice. One is that of the professional swindler who "promotes" the property for the sole purpose of transmitting the funds of the subscribers into his own pocket, and the other is the well-meaning man who perhaps has a fairly good thing if properly worked, but who has more self-confidence than experience and skill.

The ground should be surveyed,—if not accurately at least approximately—and a map prepared on which may be recorded the positions of the test-pits, the area available, and the extent of the ground worked over each season. Test-pits should be sunk at sufficiently frequent intervals to place the nature of the ground beyond conjecture. The examination should show the full depth of the gravel, the nature of the bedrock, if any, and the distribution of the values; whether they are greatest at the surface, in layers, or on the bottom. Values are never uniformly distributed, and nothing is more deceptive than a glib statement of so much per cubic yard.

The nature of the material should also be ascertained, and this not only on the surface. The sizes and percentages of the gravel, from coarsest to finest, should be measured. This is necessary to determine the character of screens to be used, or whether any at all are necessary. The action of the gravel while being washed or sluiced should be experimentally determined. Some gravels wash very freely; others, again, are of a clayey or sticky nature which renders them very difficult to wash. Other deposits are of a very hard or cemented nature, often with large boulders, which increase the difficulty of working. The condition of water supply is most important. Water is essential to the recovery of gold, and its presence in suitable quantities is a great desideratum.

The disposition of tailings is a subject which must be carefully studied. Unless the dredge can get rid of all material passed through without choking or piling up in such a manner as to interrupt its work, it is liable to be stopped, and the entire enterprise brought to a standstill until the difficulty can be remedied. The configuration of the ground, the character of the material, the depth of the water, and the height of ground worked above water,

all enter into the question and should be carefully determined. As to the gold itself, the question is threefold. There are to be considered, first, the character of the gold; second, its value per cubic yard of material handled; third, the best method of saving it. On the satisfactory determination of these points the whole success of the enterprise depends, and here long experience and sound judgment are absolutely necessary. The gold may be fine or coarse, of all degrees, and may be easy to save or difficult to save, and the most effective method of saving it depends upon its character. There is no "new discovery" for gold saving. All known methods depend on one thing for their successful action, namely, the great specific gravity of the gold as compared with gravel. Their separation can be effected only by washing with water, aided sometimes by amalgamation, but the methods of washing are subject to wide variation.—A. W. Robinson in *Cassier's Magazine* for October.

Coal Mined by Machines in 1899.*

The increase in the use of undercutting machines in the bituminous coal mines of the United States continues to be one of the most interesting features of the industry. The statistics relating to the machine-mined tonnage have been collected for 1899 as for the three preceding years, and results are presented in the accompanying table. The statement shows that the amount of coal produced by machines in 1899 was 43,963,933 short tons, an increase as compared with 1898, of 11,550,789 tons. The increase in 1898 over 1897 was 9,763,924 short tons, while the increase from 1896 to 1897 was 6,224,288 short tons. In collecting the statistics of machine mining for 1896 the inquiries were made to cover also the year 1891. The results obtained show that in 1891 the total product by machines was 6,211,732 short tons, nearly half of which was in Illinois, while Ohio made up another fourth. In 1896 the machine-mined product had increased to 16,424,932, a gain in five years of more than a million tons less than the gain each year from 1897 to 1899.

There were 22 States and Territories in which machines were used in 1899. Two States and one Territory in which a machine-mined tonnage was reported in one or more of the preceding years did not report any machines used in 1899. These were Alaska, Texas, and Utah. Maryland introduced machines for the first time in 1899, two companies installing a total of 8 air-driven pick machines, and having a product from them of 16,545 short tons. Washington, which did not report any machines in use in 1897 and 1898, is added again to the list of States using machines in 1899. The total number of States having machines in use last year was 22, against 21 in 1898, 20 in 1897, and 16 in 1896. The number of firms employing machines has increased from 136 in 1896 to 335 in 1899, while the number of machines in use has increased in the same time from 1,446 to 3,125. In the same period the total bituminous coal product of the United States has increased from 137,640,276 short tons to 193,321,987 short tons, a gain of 55,681,711 tons, or 40 per cent. The total product in the States having machines in use has increased from 115,921,828 short tons to 191,144,218 short tons, a gain of 75,222,390 tons, or 65 per cent., while the machine-mined product has increased from 16,424,932 short tons to 43,963,933 short tons, a gain of 27,539,102 tons, or 168 per cent.

Considering the statistics by States, it is seen that there were 4 States in which the machine-won product in 1899 was less than in 1898. These States were Alabama, Arkansas, Iowa, and North Dakota. Satisfactory explanation for this decrease is not given except in Arkansas, where some of the large mines using machines were idle because of strikes a good part of the year. New Mexico reported a decrease from 29 to 15 in the number of machines in use, but a substantial increase in the tonnage. Pennsylvania is credited with the largest increase, 258 machines and 5,488,242 tons being added to the figures for 1898. Illinois comes second in the increase of tonnage, adding 2,669,677 tons to the machined product of 1898. Prior to 1899, the amount of coal won by machines in Illinois had not reached 4,000,000 tons in any one year. In 1899 it exceeded 6,000,000 tons. This remarkable increase in 1899 is explained in part by the fact that a large number of machines reported in 1898 were not introduced until late in that year, and their influence on the tonnage was not apparent. Further explanation is found in the strikes which paralyzed the coal-mining industry of Illinois in 1898, causing a decrease of nearly 1,500,000 tons in the total product, and affect-

ing particularly some of the mines in which machines were used. There was a decrease of over 500,000 tons in the machine-mined product of Illinois in 1898 as compared with the preceding year. West Virginia was next to Pennsylvania in the number of machines added in 1899. There was a gain of 68 machines in West Virginia in 1899 as compared with 1898, but as some of these were not installed until late in the year the tonnage did not increase in proportion. There was, however, an increase of over 550,000 tons in the machine-mined product. Ohio added 33 machines to the number reported in 1898 and 1,631,149 tons to the product won by them. Colorado increased the number of machines in use from 43 to 63, and added over 300,000 tons, or about 133 per cent, to the machine tonnage. In this State, as in Illinois, the product in 1898 was reduced by strikes. The changes made in the other States were unimportant.

The coal mined by machines in 1899 constituted 23.00 per cent of the total product as compared with 20.39 per cent in 1898, 16.19 per cent in 1897, and 14.17 per cent in 1896.

In the following table is exhibited a detailed statement of the number of machines of each make in use in the bituminous coal mines of the United States in 1899. The pick or "punching" machines exceed in number, there being 1,997 out of a total of 3,125. Of the remainder, 1,106 were chain breast machines and 22 longwall. The latter are used only in the States west

KINDS OF MACHINES USED IN BITUMINOUS COAL.

State.	No. of Firms Using Machines.	Pick Machines.				Chain Breast Machines.						Long Wall.	Total.	Tonnage Mined by Machines in 1899.
		Harrison.	Sullivan.	Ingersoll-Sergeant.	Others.	Jeffrey Air.	Jeffrey Electric.	Independent, or Link-Belt.	Morgan-Gardner.	Morgan-Standard.	Others.			
Alabama.....	5	2	1	38	.....	10	.....	.....	.....	.....	.....	2	53	260,442
Arkansas.....	1	.....	.....	.....	.....	.....	12	.....	.....	.....	.....	.....	16	146,899
Colorado.....	3	27	2	5	3	3	19	4	.....	.....	.....	.....	16	527,115
Illinois.....	64	180	85	130	18	.....	89	23	15	.....	.....	.....	440	6,085,312
Indiana.....	15	149	6	8	.....	.....	.....	5	63	12	.....	4	247	1,713,125
Indian Territory	4	22	1	30	.....	.....	14	2	.....	.....	.....	.....	74	276,180
Iowa.....	4	22	.....	.....	.....	9	4	.....	.....	.....	.....	6	41	124,721
Kansas.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	40,271
Kentucky.....	16	89	11	39	.....	8	14	15	13	.....	.....	.....	189	1,625,809
Maryland.....	2	.....	.....	6	.....	.....	.....	.....	7	.....	.....	.....	8	16,545
Michigan.....	2	12	.....	6	.....	.....	1	.....	.....	.....	.....	.....	26	64,065
Missouri.....	3	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	8	9	55,154
Montana.....	3	35	.....	30	.....	.....	1	9	.....	.....	.....	.....	76	843,710
New Mexico.....	2	.....	.....	.....	.....	.....	1	4	9	.....	.....	.....	14	260,778
North Dakota.....	2	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	38,066
Ohio.....	53	16	.....	2	.....	31	100	2	112	3	12	.....	278	6,822,524
Pennsylvania.....	103	386	236	254	68	50	198	25	122	.....	.....	4	1,343	22,000,722
Tennessee.....	5	2	4	10	.....	.....	6	.....	.....	.....	.....	.....	22	208,683
Virginia.....	1	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....	2	265,000
Washington.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	14,640
West Virginia.....	38	40	15	.....	.....	.....	40	6	53	.....	.....	.....	151	1,881,125
Wyoming.....	8	7	2	38	.....	3	.....	.....	.....	.....	11	.....	56	693,712
Total.....	335	992	317	590	98	114	450	95	401	15	31	22	3,125	43,963,933

of the Mississippi River—Arkansas, Iowa, Kansas, and Missouri. The pick machines include 992 Harrison, 317 Sullivan, 590 Ingersoll-Sergeant, and 98 "other" makes, or of which the make was not reported. The chain machines include 114 Jeffrey air, 450 Jeffrey electric, 401 Morgan-Gardner electric, 95 Independent or Link-Belt electric, 15 Morgan-Standard electric, and 31 other.

What is Seigniorage?

This term, as used in the United States, means the profit arising from the coinage of bullion. The Government does not purchase gold bullion, but coins it on private account. There is no profit from the coinage of gold bullion, the face value of gold coins being the same as their bullion value, but at the present ratio of 16 to 1 the face value of the silver dollar is greater than its bullion value; therefore when silver bullion is purchased and coined into dollars there is a profit arising from such coinage, the amount of which depends upon the price paid for the bullion. For example, there are 271½ grains of pure silver in a dollar and there are 480 grains of pure silver in a fine ounce. The coinage value of a fine ounce is therefore \$1.2929. If the fine ounce can be purchased for 70 cents, the profit of its coinage (the seigniorage) is \$0.5929—, and the profit on the 371½ grains of pure silver in the single dollar is \$0.4586—, which is the difference between the actual cost of the bullion in the dollar and the nominal value of the coin. The silver purchased by the Government is carried on the books of the Treasury at its actual cost, and the seigniorage is declared on the coinage of each month and paid into the Treasury.

*Extract from the "Production of Coal in 1899," by E. W. Parker, U. S. Geological Survey, Washington, D. C.

COMPRESSED AIR LOCOMOTIVE.

Some of the Reasons Why They Are Often Preferred in Mines. Principles Governing Their Construction.

Written for MINES AND MINERALS, by H. K. Myers, C. E.

Locomotive haulage in mines has for many years proven very efficient where conditions were favorable. When the grades do not exceed for short distances 5% and an average of 3% maximum against the loads, or for short distances 8% and average of 5% maximum in favor of loads, it has been found in general that it is the most economical form of haulage.

The chief advantages of locomotive over rope haulage are the flexibility of the system, it being able to serve any number of side tracks in various parts of the mine, and the closeness of the source of power to the point of application. In the event of an accident due to a car jumping the track, a broken wheel, etc., it often happens that a large number of cars are piled up before the man in charge outside the mine is signaled to stop, whereas with locomotive haulage the engineer or trip rider affords immediate relief.

Where the seam of mineral is high and the location such that there is neither inflammable gases nor danger of vitiating the air, steam locomotives are found very economical as has been specially proven in the Pocahontas coal field of West Virginia. Even there, with their high seams, it has been determined that there is a limit to this form of haulage. It is not found feasible to fire while running in the mine, especially when bituminous coal is used, hence the length of the trip underground is limited to the

storage at least double that of the locomotives comprising the system. This allows an equalized pressure in the locomotive storage of approximately 600 lb.

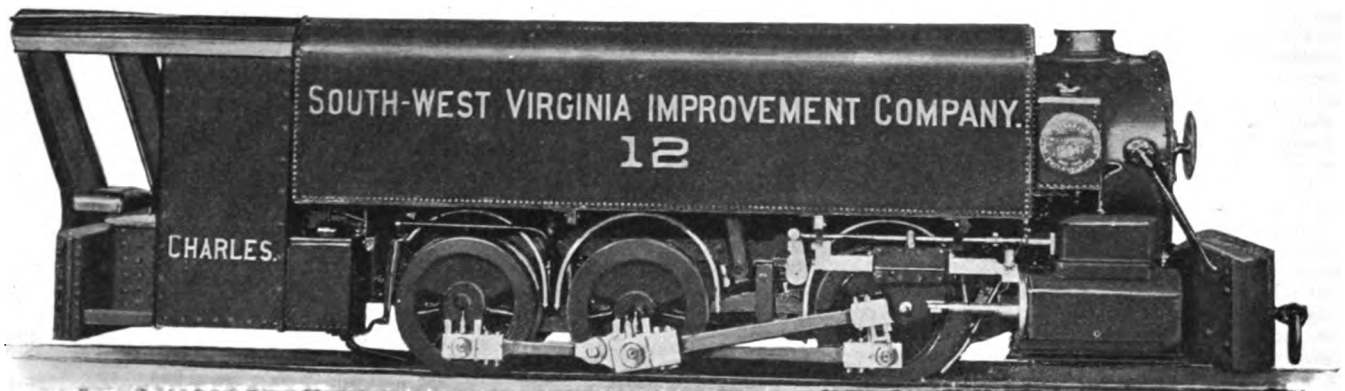
The following formula is useful in determining the capacity of stationary storage: V = volume of storage on locomotive; X = volume of stationary storage desired; p = cylinder pressure; P = stationary storage pressure; and P' = locomotive storage pressure.

Now, since it is considered good practice to use the air from the locomotive storage until it has been reduced to the cylinder pressure, we would have it applying for a charge when it contained a pressure of p . Then $\frac{pV + PX}{V + X} = P'$, that is, the

product of the storage on the locomotive by its pressure added to the product of the stationary storage by its pressure and the sum divided by the combined volumes will give the equalized pressure or the final pressure in the locomotive storage.

If the average time for each trip is 30 minutes, the compressor must be able to compress in that time to pressure P the calculated amount of air required for one trip or series of trips for the various locomotives included in the haulage. In general, it is customary to extend extra strong pipe into the mine and of such length and diameter as to have the required volume for the stationary storage. There are times however when it would be found more economical to arrange for tank storage either inside or outside the mine but in general, especially when the mine is advancing, it is the better practice to install pipe storage since it increases the range of the locomotive as the workings advance.

Table No. 1 gives the various tractive efforts of different sizes



A 60,000 LB. MINE LOCOMOTIVE.

steam furnished with one fire-box of fuel. It is customary to fill the fire-box, and, after the greater part of the darker colored gases have passed off, to take the empty trip into the mines returning with the loaded cars, all with the one fire-box of coal. Possibly the largest locomotive ever constructed for mine haulage is the one shown in the accompanying figure. It was built for the Southwest Virginia Improvement Co., Pocahontas, W. Va., and weighs 60,000 lbs. with everything in proportion. This locomotive is able to make a round trip of seven miles without firing and on account of the dimensions is possibly the maximum for steam mine locomotives.

To overcome the many difficulties and dangers incident to the use of steam locomotives underground, a large variety of both compressed air and electric locomotives have been designed in recent years and in general they have been very successful and show a marked efficiency over the mule.

In order that compressed-air locomotives may be able to make a fair length of run, the tanks for storage purposes must necessarily be rather cumbersome, and constructed to carry high-storage pressures. In order that they may be designed correctly and get a minimum of storage for the maximum work expected, it is necessary to have a complete profile of the proposed haulage, and to make a tabulated statement of the air consumption on the various grades, noting the "cut-off" necessary to produce the requisite tractive effort. By making a summation of these various amounts, and adding 20%, we will have the possible amount of air used in doing certain work as specified.

It is necessary, therefore, to provide storage on the locomotive for this amount of air at a much greater pressure than that used in the cylinders. In order that the locomotive may receive a quick charge at the stations specially provided for the purpose, it is necessary to have the stationary storage of adequate pressure and capacity for the purpose.

At the present time, it is the custom to compress for the stationary storage to 800 lb., and to have the volume of this

of compressed-air locomotives, when working at 100 lb. cylinder pressure, and various cut-offs. If other pressures or strokes are used, the tractive efforts are directly proportionate. This table is calculated by means of the formula,

$$\text{tractive effort} = \frac{d \times l \times x p}{D}$$

in which d = diameter of cylinder; D = diameter of driver; l = length of cylinder or stroke; p = working pressure of the cylinders; and x = variable due to the various cut-offs.

TABLE NO. 1.

TRACTION EFFORTS OF COMPRESSED-AIR LOCOMOTIVES.

Cylinder.		Diameter of Driver. Inches.	Weight on Driver. Pounds.	Tractive Effort for Each 100 lb. Cylinder Pressure at Various Cut-Offs.						
Diam. Inches.	Stroke. Inches.			1"	2"	3"	4"	5"	6"	7"
5	10	24	6,000	1,020	990	920	835	710	530	325
6	10	24	8,500	1,470	1,425	1,320	1,200	1,020	760	445
7	12	26	13,000	2,200	2,150	1,990	1,810	1,540	1,140	700
8	12	26	18,000	2,890	2,760	2,600	2,360	2,000	1,510	900
9	14	26	25,000	4,340	4,140	3,840	3,490	2,960	2,220	1,350
10	14	26	32,000	5,280	5,150	4,740	4,310	3,660	2,630	1,670
11	16	28	42,000	6,770	6,450	5,980	5,440	4,620	3,470	2,440
12	16	28	52,000	8,050	7,800	7,200	6,560	5,580	4,150	2,850

On account of certain losses due to radiation, etc., for cut-off at full length of stroke in steam practice x is taken as .85. While cylinder surface acts as a detriment to the use of steam, it acts entirely opposite in the use of air, for the reason that, in the expansion of the air, very low temperatures are produced, and, with a maximum of cylinder surface exposed, we absorb a maximum of heat from the surrounding air, which virtually adds new energy to the air, thus acting as a reheater. Therefore, in air

practice, this factor x is made .95 for full-stroke cut-off, with the others proportionately high. If simple-expansion cylinders are used, the working pressure should not exceed 130 lb., while, with compounds, one can easily use from 180 to 225 lb. with great economy.

Where it is imperative to have a minimum-sized locomotive storage with a maximum run, this can be accomplished with compound locomotives, since by using the air at high pressures advantage is taken of the energy developed by the expansion of the air from the higher to the lower working pressure. If we have two locomotives, one working at 200 lb. and the other at 130 lb., the former should have an efficiency over the latter, simply due to the working pressure, of an amount equal to the power necessary to compress the air used from 130 lb. to 200 lb. If both locomotives were simple cylinders and of same diameter, it is possible that the higher pressure would prove the more inefficient for the reason that the exhaust pressure would be very high and the leakage very great. By the use of compound cylinders any leakage in the high pressure cylinders is caught in the low pressure without loss.

Originally, it was the custom to lag the cylinders as in steam practice, but now it is found advantageous to leave them bare and to corrugate both sides and ends so as to present a maximum surface to the surrounding atmosphere while running, thus absorbing new energy.

In order that the method of making calculations may be fully understood we will figure out a haulage from the data given, most of the calculations being made with the slide rule, and though not extremely accurate they are in all cases taken above the actual values so as to be on the safe side.

EXAMPLE.—It is desired to haul trips of 60 cars, empties weighing 2,000 lb. and loads 6,000 lb. each, over a track having the following profile, and with one charge of air. All grades are in favor of loads.

PROFILE OF ROAD.

Grade %.	Distance.	Grade %.	Distance.	Grade %.	Distance.
1.3	800 ft.	0.3	700 ft.	2.4	400 ft.
2.0	600 ft.	1.77	1,025 ft.	3.5	425 ft.
1.3	800 ft.	0.9	300 ft.	1.2	820 ft.

The maximum grade being 3.5 per cent., and the car friction in this case being 1 per cent., the total resistance when ascending a 3.5 per cent. grade due to cars is, hence, $3.5 + 1 = 4.5$ per cent. Since it is desired to haul 60-car trips, and all grades are in favor of loads, it is only necessary to provide a locomotive capable of hauling 60 empties weighing 120,000 lb. up the above-mentioned grade.

The drawbar pull necessary to do this is 4.5 per cent. of 120,000 lb. = 5,400 lb. In general, it will require a locomotive having a weight on drivers of five times the tractive effort desired if steel tires are used, as is the practice in the construction of air locomotives, and 6 times the tractive effort if cast-iron chilled wheels are used, as is the practice in electric locomotives. We will, therefore, assume the necessary weight of the locomotive to give the proper adhesion as 32,000 lb., and we calculate that the tractive effort necessary to haul itself up the 3.5 per cent. grade would be $3.5 + .5 = 4$ per cent. (.5 per cent. covering the friction of the locomotive on the level) of 32,000 lb., or 1,360 lb., to which we add the necessary drawbar pull to haul the desired load, 1,360 + 5,400, and have a total tractive effort of 6,760, which is about the limit of our locomotive on dry rail with sand.

By consulting the table No. 1 we see that, at 100 lb. working pressure, a 10 in. $\times$ 14 in. 28 in. driver locomotive has a maximum tractive effort at $\frac{1}{2}$ in. cut-off, which is practically full stroke, of 5,280 lb., and by dividing this into our necessary tractive effort, we find that the necessary working pressure would be about 130 lb.

On this basis, we then make up the following table in order to ascertain the necessary air consumption:

GOING IN WITH EMPTIES.					
Grade.	Distance.	T. E.	Strokes.	Cut-Off.	Cu. In. Air Used.
1.3	800'	3,375	120	$\frac{1}{2}$ in.	126,000
2.0	600	4,450	80	$\frac{1}{2}$ in.	176,000
1.3	800	3,375	120	$\frac{1}{2}$ in.	126,000
0.3	700	1,880	105	$\frac{1}{2}$ in.	55,125
1.77	1,025	4,100	150	$\frac{1}{2}$ in.	315,000
0.9	300	2,750	40	$\frac{1}{2}$ in.	42,000
2.4	400	5,075	60	$\frac{1}{2}$ in.	157,600
3.50	425	6,760	65	$\frac{1}{2}$ in.	239,000
1.2	820	2,220	50	$\frac{1}{2}$ in.	52,600
COMING OUT LOADED.*					
0.3	700	2,800	105	$\frac{1}{2}$	110,000
20 per cent. additional					1,399,125
Total					279,825
					1,678,950 cu. in.

This equals 975 cu. ft. at 130 lb. pressure used in hauling the required loads on a single round trip. Since we should return

*Returning with loads, it is possible that there is only one grade that the trip will have to be hauled.

to the starting point with 130 lb. in the locomotive storage, it is evident that the volume of the tanks must allow for the use of 975 cu. ft. in addition to 1 volume at 130 lb.

Let V = volume of storage on locomotive;
 P' = pressure of storage on locomotive;
 p = working pressure;
 V' = volume at working pressure necessary to do the work required.

Then the product of the volume of the locomotive storage by its pressure must equal the sum of the volume necessary to do the work required multiplied by the working pressure, and the locomotive storage volume by the working pressure, thus,

$$P'V = pV + pV', \text{ or, } V = V' \frac{p}{P' + p}.$$

$$\text{If } P' = 650, \text{ then } V = 975 \frac{130}{650 + 130} = 244 \text{ cu. ft.}$$

With one locomotive of this kind in service and making trips every 30 minutes, we must arrange for a compressor capable of compressing 975 cu. ft. at 130 lb. in this time. Since it is customary to rate compressors at their capacity in free air per minute, the above is equivalent to $\frac{975 \times 130}{14.7 \times 30} = 288$ cu. ft. free air per minute.

This must be compressed to 800 lb. in the compressor, and stored in stationary storage. If X is the volume of the stationary storage, $P' = \frac{pV + PX}{V + X}$.

$$X = V \frac{P' - p}{P - P'}, \text{ or } X = 244 \frac{650 - 130}{800 - 650} = 846 \text{ cu. ft.}$$

The length of the haulage is 5,385 ft., hence the cross-section of the pipe necessary to furnish the requisite storage is

$$\frac{846}{5,385} = .157 \text{ sq. ft.}$$

From table No. 2 this would require a $5\frac{1}{2}$ in. pipe, but for practical purposes it is possible that a 5 in. pipe would be selected.

 TABLE NO. 2.
 STANDARD STEAM AND EXTRA STRONG PIPE USED FOR COMPRESSED-AIR HAULAGE PLANTS.

Trade Diameter. In.	Cu. Ft. in 1 Lineal Ft.	Lineal Ft. Necessary to Make 1 Cu. Ft.	Steam.		Extra Strong.		Trade Diameter. In.
			Thick-ness.	Weight per Ft.	Thick-ness.	Weight per Ft.	
2	.0218	45.41	.15	3.61	.22	5.02	2
2 $\frac{1}{2}$	.0341	29.32	.20	5.74	.28	7.67	2 $\frac{1}{2}$
3	.0491	20.36	.21	7.54	.30	10.20	3
3 $\frac{1}{2}$	.0668	15.00	.22	9.00	.32	12.50	3 $\frac{1}{2}$
4	.0873	11.52	.23	10.70	.34	15.00	4
4 $\frac{1}{2}$	.1105	9.05	.24	12.30	.35	17.60	4 $\frac{1}{2}$
5	.1364	7.33	.25	14.50	.37	20.50	5
5 $\frac{1}{2}$	.1650	6.06	.26	16.40	.40	24.50	5 $\frac{1}{2}$
6	.1963	5.10	.28	18.80	.43	28.60	6

Table No. 3 gives the horsepower necessary to compress 100 cu. ft. free air per minute, and from it we see that it would require $2.88 \times 32.5 = 93.6$ H. P., hence, we would be compelled to arrange for a boiler capacity of practically 100 H. P., provided we used a three-stage compressor, as is the general custom.

 TABLE NO. 3.
 HORSEPOWER NECESSARY TO COMPRESS 100 CU. FT. OF FREE AIR TO VARIOUS PRESSURES AND WITH TWO-, THREE-, AND FOUR-STAGE COMPRESSORS.

Gauge Pressure.	Horsepower Necessary.			Gauge Pressure.	Horsepower Necessary.		
	Two-Stage.	Three-Stage.	Four-Stage.		Two-Stage.	Three-Stage.	Four-Stage.
100	15.7	15.2	14.2	900	36.3	33.7	31.0
200	21.2	20.3	18.8	1,000	37.8	34.9	31.8
300	24.5	23.1	21.8	1,200	39.7	36.5	33.4
400	27.7	25.9	24.0	1,400	41.8	37.9	34.5
500	29.4	27.7	25.9	1,600	43.0	39.4	35.6
600	31.6	29.5	27.4	1,800	44.3	40.5	36.7
700	33.4	31.2	28.9	2,000	45.4	41.6	37.8
800	34.9	32.5	30.1	2,500		43.0	39.0

In the use of such high pressures too much care cannot be given the construction of the pipe line. It is found necessary to use specially designed flanges, bends made from the same kind of pipe as that composing the line and "tees" of specially heavy construction.

The flanges should average about 250 apart and all joints

screwed as tight as possible. It is preferable to support the pipe near the roof on posts specially set for the purpose. If laid on the ground they will soon deteriorate from the moisture collecting on them. There should be drip cocks at all low points so that the pipe can be drained from time to time. Where there is a large amount of dust in the atmosphere from which the air supply comes it is good practice to filter the air through water and although this method thoroughly saturates it with moisture yet it produces no serious trouble in compressing.

Production of Coal, by States.

By E. W. Parker.*

Including an insignificant product from Idaho and the Territory of Alaska, there were thirty States and Territories that contributed to the output in 1899, as in the preceding year. Of these thirty States, nineteen produced over 1,000,000 tons each in 1899, seven had an output exceeding 5,000,000 tons each, four exceeded 10,000,000, and two—Pennsylvania and Illinois—exceeded 20,000,000 tons. As is well known by all familiar with the coal trade, Pennsylvania stands preeminently at the head of the coal-producing States. The combined output of anthracite and bituminous coal in Pennsylvania has for many years exceeded 50 per cent. of the total output of the United States. The lowest percentage contributed by Pennsylvania in any of the years for which statistics are available was 52, in 1884 and 1888, while in 1880 it was as high as 65. In 1899, 53 per cent. of the total product was from Pennsylvania mines; 29 per cent. was Pennsylvania bituminous coal and 24 per cent. Pennsylvania anthracite. With such a record it is not probable that Pennsylvania will be supplanted as the leading coal producer during the next fifty or one hundred years. It has been estimated that at the present rate of consumption the anthracite fields of Pennsylvania will last from one hundred and fifty to two hundred years. And while industrial activity does not affect anthracite operations as much as it does bituminous mines, the production and consumption is stimulated in seasons of business revival such as that which prevailed during the past year. Anthracite production in Pennsylvania in 1899 increased 13 per cent. over 1898, as compared with an increase of 13.8 per cent. in Pennsylvania bituminous coal and a gain of 16 per cent. in the total bituminous product of the United States. Anthracite coal is becoming more an article of domestic consumption every year, while its use under boilers and for manufacturing purposes is being supplanted to a large extent by soft coal. It is not to be expected that its production will increase in the same proportion as bituminous coal, but with our increasing urban population its use as a domestic fuel may continue to increase for at least some time to come. Nor is it possible to predict what the rate of increase, if any, is going to be, but it is probable that for the next fifty years at least 20 per cent. of our total product will be made up of Pennsylvania anthracite. The State will continue as the leading coal producer for many years, if the history of the past may be taken as a basis for judging of the future.

Next in importance to Pennsylvania as a coal producer is Illinois, whose product in 1899 was 24,439,019 short tons, equivalent to 9.6 per cent. of the total product, and a gain of nearly 6,000,000 tons over the State's output in 1898. West Virginia, the third State in importance as a coal producer, increased her output 15.3 per cent., from 16,700,999 short tons in 1898 to 19,252,995 short tons in 1899; and while this product in 1899 exceeded that of Illinois for 1898, the latter's increased output in 1899 continues the State in second place, with a lead of over 5,000,000 tons ahead of West Virginia. Ohio remains in undisputed possession of fourth place, with a product of 16,500,270 short tons in 1899, a gain of nearly 2,000,000 tons, or 13.6 per cent. Alabama remains as firmly fixed in fifth place, with a total of 7,593,416 short tons in 1899, against 6,535,283 tons in 1898, recording an increase for last year of over a million tons.

It will be observed that all of these five leading States are east of the Mississippi River, and all but one, Illinois, belong to the Appalachian system. The sixth State in importance is Indiana, also east of the Mississippi River. Iowa, the most important coal-producing State west of the river, is seventh in the list of all the States, having displaced Maryland in 1899. Following Iowa are, in order, Maryland, Colorado, and Kentucky, contending for supremacy, each with a product exceeding 4,500,000 tons and less than 5,000,000.

Continuing the Mississippi River as a dividing line for a geographical distribution of the product between the eastern and western States, it is found that the production of the States east of the river was 224,096,219 short tons, or 88.3 per cent. of the total, in 1899, as against 193,793,334 short tons, or 84.3 per

cent, in 1898. The western States produced 29,643,773 short tons, or 11.7 per cent., in 1899 and 26,181,333 short tons, or 15.7 per cent., in 1898. Subdividing the eastern division into northern and southern States by the Potomac and Ohio Rivers, we find that the States north of the boundary produced 187,031,987 short tons, or 73.7 per cent., in 1899, as compared with 161,575,292, or 65 per cent. of the total, in 1898. The southern States produced 37,064,232 short tons, or 14.6 per cent. of the total, in 1899, and 32,218,042, or 19 per cent., in 1898.

The percentage of increase in production of the three divisions from 1898 to 1899 was as follows: Northern, 15.80; southern, 15.04; western, 13.22.

John A. Roebling's Sons' Exhibit.

The John A. Roebling's Sons Company, of Trenton, New Jersey, has received for its exhibit at the Paris Exposition two "Grand Prizes" and two gold medals, the highest honors within the gift of the Exposition authorities.

The Roebling display at the Exposition consists of two exhibits. One shows the product of the company's electrical department, and the principal feature of it is a full size model of a section of underground trolley track, illustrating the communications with the conductive bars and the lead-encased cables which transmit the current to the cars by means of connections known as ploughs.

The value of this exhibit rests on its showing the actual piece of underground trolley with the pavement cut away and is very instructive both to engineers and to the general public.

All kinds of telephone wires and cables are also shown with the means of connecting up and mounting.

Besides this there are very beautiful samples of every variety of wire used in electrical industries, all kinds of which are manufactured by the Roebling Company.

The most recent developments in electrical cables for carrying currents of the highest tension or greatest number of volts are illustrated in full size pieces.

This exhibit met with such favor with the jury that it was awarded a "Grand Prize" the highest award conferred by the Exposition authorities.

The second exhibit is in the department of metallurgy, and gives a comprehensive view of all the products of the Roebling works with the exception of the electrical conductors.

The United States Paris Exposition Commission approached the Roebling Company about a year ago to sound it with reference to the installation of a striking feature in the nature of a trophy. The Roebling Company consented to erect for the purpose a large model of the Brooklyn Bridge.

This is an exact representation of the famous suspension bridge, and surmounts the exhibit proper.

The first model of the bridge that was built for the Exposition was lost with the unfortunate "Paulliac" which was reported near her destination some six days after sailing and was never heard from afterward.

The Roebling Company, however, built a second model in six weeks and had it in its place about a month after the Exposition opened. The bridge was entirely built at the Roebling plant and is very graceful and pleasing to the eye.

Several cases with glass doors and shelves, form a part of the exhibit and contain samples of every variety of steel and copper wire from the largest sizes made, to wire with a diameter of $\frac{1}{100}$ of an inch. This latter is so fine that it is impossible to detect it between the fingers. It is half as thick as the finest human hair and a mile of it weighs about a quarter of an ounce. It is drawn through diamond dies, and is a good example of the skill displayed by the workmen in the process of manufacture.

The Roeblings are famed all over the world for the high quality of their wire ropes and cables, and these products of their mills are given a very prominent place in the exhibit.

There are also two full size sections of the cables of the Brooklyn Bridge.

The Roeblings were awarded for this exhibit a "Grand Prize" and a gold medal.

The company has exhibited at all of the prominent expositions for a number of years and possesses many awards conferred, including gold and other medals. At the Centennial, at the World's Fair in Chicago and at the Philadelphia Export Exposition, the excellence of its manufactures was generously acknowledged.

The Roebling Company in the last two years has built a large wire mill, probably the most extensive single mill in the world, and has added a number of buildings for various purposes. The company has in its employ about 3,000 operatives, and is at present more than doubling its office accommodations, and is building a new mill for electrical conductors which will increase the capacity of that department about 30 per cent.

* Extract from "The Production of Coal in 1899," U. S. Geological Survey Report, Washington, D. C.

NEW INVENTIONS.

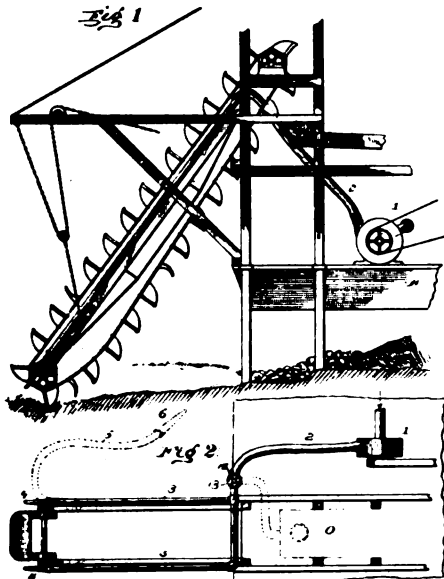
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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DREDGING APPARATUS.

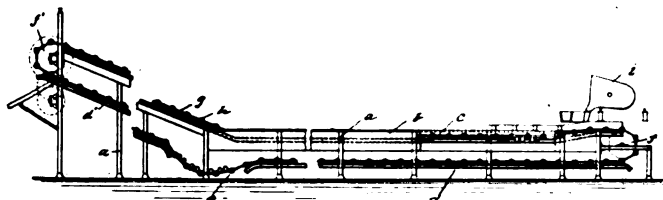
No. 657,247. A. McDougall, Duluth, Minn. *Patented Sept. 4, 1900.* This invention is intended to cover certain features of a dredging apparatus for working placer deposits, the object being to work out a portion of the meadow by removing practically all of the gravel from the bed rock while the dredge floats upon the water in the pit. In the meanwhile an auxiliary pit or reservoir is dug to one side to contain a supply of water. The pit is then pumped out, the dredge supported upon spiles or spuds and the bed rock cleaned, water for this purpose being obtained from the reservoir. The patent is intended to cover this feature and also the use of jets of water under pressure for loosening the ground at the point at which the dredge operates.



This feature is illustrated in Figs. 1 and 2. Fig. 1 represents a side elevation of a portion of the dredge scow *A* which is supported by spuds as shown. Upon this scow is placed a suitable centrifugal pump *1*, forcing water through a flexible tube *2* to the head of the ladder supporting the bucket elevator. Along the side of this ladder permanent pipes *3* are arranged which are provided with nozzles *4* at their lower end. During the excavation of the pit, jets of water from these nozzles aid the dredge in loosening and removing the soil. After the pit has been excavated and the bucket elevator is being used to clean bed rock the nozzles may be removed and the hose attached to the ends of the pipe as shown by the dotted lines *5*, in Fig. 2. This hose is provided with a nozzle *6* and is used for washing the material on the bed rock into the pit in which the bucket elevator is operating. The centrifugal pump *1* may also be used for throwing an extra supply of water through the sluice *0* by providing a 3-way valve *15* at the head of the ladder and a pipe as indicated by the dotted lines.

ENDLESS CONVEYER.

No. 657,048. A. M. ACKLIN AND W. J. PATTERSON, PITTSBURG, PA. *Patented, Aug. 28, 1900.* The conveyer covered by this patent is intended to be used in connection with a casting machine and has certain novel features for removing the heat and overcoming expansion. In the accompanying figure, *a* represents suitable supports for carrying the conveyer tracks *d* and *d'* for the return conveyer and the tracks *c* for the loaded conveyer. The conveyer carries suitable

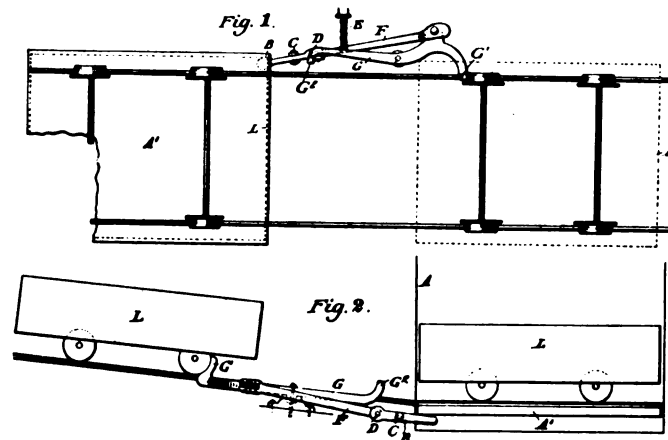


molds which are filled from a ladle *i* or by any other convenient method. A portion of the conveyer adjacent to the filling end is submerged in the tank *b* which contains a suitable cooling solution. The discharge end of the conveyer is elevated and passes about a wheel *f'* which may be a driving wheel, the other end of the conveyer being supported by a suitable wheel *f*. In order to overcome the expansion of the chain the return track may be provided with a gap *e* situated

between the portions *d* and *d'*. As the conveyer expands it will sag further into this gap. If desired, the gap may be replaced by a sag in the track which is made to conform approximately to the greatest sag in the conveyer, so that as the conveyer cools it will lift clear of this sag in the track. The conveyer chain proper may be made of any suitable design, as, for instance, links *g* may be carried upon the rollers *h* the axes of which form the pins for connecting the links.

SELF-ACTING MINING-DOG.

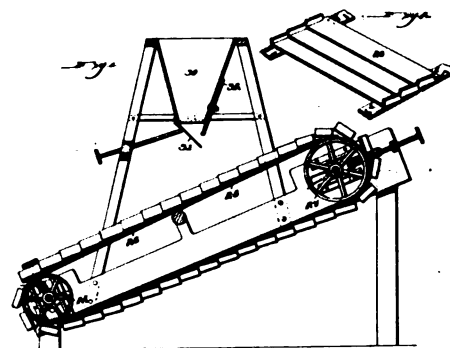
No. 656,279. W. A. WILSON, MURPHYSBORO, ILL. *Patented Aug. 21, 1900.* This invention provides a device for automatically loading the cars onto the cage at the bottom of a mining shaft, and is illustrated by the



two accompanying figures. In both figures there is a car upon the cage *A* ready for hoisting. The cage in its descent strikes the lever *B* which is fulcrumed at *C* and connected at *D* to the pitman *F*. This pitman throws the piece *G* in such a manner as to draw the dog *G'* away from before the front wheel of the first car on the inclined track, thus allowing it to run onto the cage as shown. In order to prevent the next car from following, the dog *G'* is thrown in as shown. When the cage is hoisted the lever *B* is released and the spring *E* immediately returns the lever *G* to its place. This removes the dog *G'* from before the carwheel allowing the car to pass on until the wheel rests against the dog *G'*, so that the apparatus is ready to load another car as quickly as the cage comes down again.

SLATE AND COAL SEPARATING DEVICE.

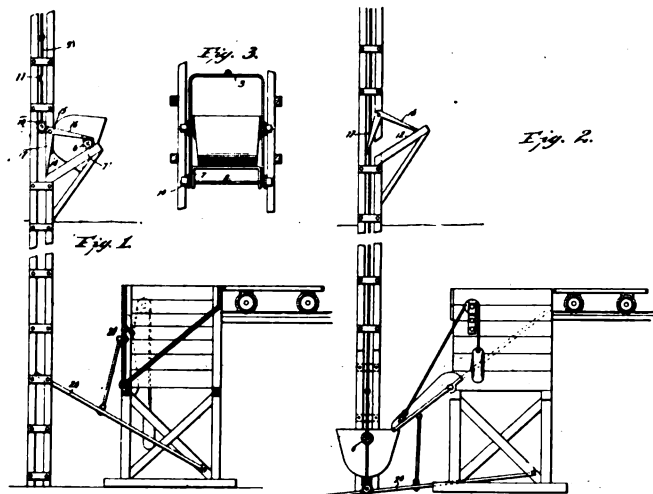
No. 655,161. P. F. POORBAUGH, ALLEGHENY, PA., ASSIGNOR OF ONE-HALF TO FREDERICK C. MANCOURT, OF BELLEVUE, PA. *Patented July 31, 1900.* This invention is a continuous carrier adapted to separate coal from slate, the coal traveling in an opposite direction to that of the slate during the separating. The carrier for separating coal and slate consists of a pair of continuous strips *25* of suitable material mounted upon the drums *22*, *24*. Mounted on these strips is a series of rectangular inclined metal plates *26*, secured at their upper ends, to the strips *25*, as shown, and overlapping each other at their lower ends. The sides of these plates are bent at an angle, forming a flange to retain the coal and slate upon the carrier. The upper end of each of these angle portions of the plates *26* is cut away to permit of the overlapping of adjacent plates. The hopper *30* is provided with a hinged bottom *31*, forming a chute, and with a slide *32*, adjusted by means of bolts. The operation of the separator is as follows: The drums revolving move the carrier, and as the coal and slate are placed on the series of metal plates forming the carrier the coal will ride downward and be discharged over the drum at the lower end thereof, while the slate will be carried upward and be discharged at the upper end.



APPARATUS FOR LOADING OR UNLOADING MINE CAGES OR BUCKETS.

No. 654,270. JOHN F. MCKAY, OF PROSPERITY, MISSOURI, ASSIGNOR OF ONE-HALF TO JOHN RAYMOND AND CLAUD D. RAYMOND, OF WEBB CITY, MISSOURI. *Patented July 24, 1900.* A bucket attached to a rope by a bail is guided between two guides in the usual manner. The bucket is provided at opposite sides of its upper portion with rollers or wheels *6*, and it has arms *7* depending from its bottom and provided with openings for

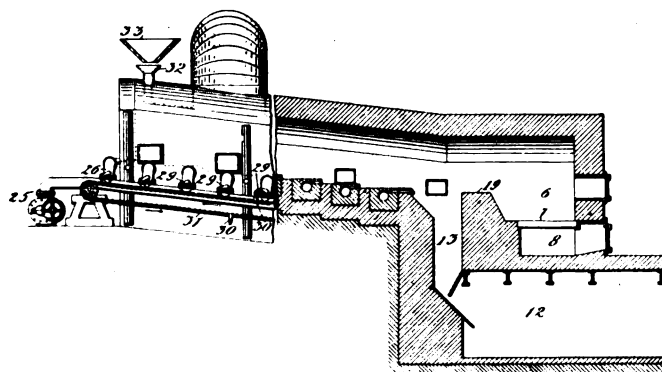
the reception of a transverse rod 8. The ends of the rod extend outward beyond the arms and form an axle for a pair of lower rollers or wheels 10. The bail 5 is connected with the rod 8 at the outer faces of the arms 7 and is provided near the centers of its sides with bends 11 to enable it to clear the journals 6 and at the same time to lie centrally of



the bucket. The bucket swings outward on 8; inclined side tracks or rails 12 extend from the upper portion of the guides or ways to receive the upper wheels 6, as illustrated in Fig. 1, when the bucket reaches the limit of its upward movement. Pivoted switches are mounted adjacent to the side openings 14 to cause the upper rollers or wheels to move laterally through the openings 14. The lower depending arm of the switch, which is lighter than the upper outwardly-extending arm, is disposed across the guide or way, as shown in Fig. 2, when the switch is in its normal position, whereby it is adapted to switch the upper rollers or wheels upon the side tracks or rails. The further upward movement of the bucket causes the upper rollers to engage the arms 16, which are lifted sufficiently to throw 17 outward to a vertical position to close the side openings temporarily, as illustrated in Fig. 2. The arms 17 of the switches when arranged in a vertical position cause the lower rollers or wheels to move vertically in the guides or ways past the side openings of the same, to elevate and invert the bucket, and discharge the contents. The bucket is filled from a hopper, having an inclined bottom and located below the level at which the mining operations are carried on. The hopper is provided at its front, adjacent to the shaft, with a hinged gate 20, adapted to form a chute when the same is open, whereby the contents of the hopper will be discharged into the bucket. The gate or door is normally held in a vertical or closed position by a weight, attached to one end of a rope or other flexible connection, which passes over a pulley and is secured to the gate near its upper edge. The automatic opening of the gate is effected by means of a lever 26. When the bucket descends, the transverse rod or axle 8 engages the lever, which is arranged in an inclined position when the gate is closed and which is swung downward by the weight of the bucket to the position illustrated in Fig. 2. This brings the hinged gate in position for discharging the contents of the hopper into the bucket, and the capacity of the hopper should be substantially the same as that of the bucket, so that none of the contents will be wasted. As soon as the bucket rises with its load the weights automatically close the gate and swing the lever upward to the inclined position shown in Fig. 1.

CALCINING OR ROASTING FURNACE.

No. 658,580. A. E. JOHNSON, VICTOR, COLO. Patented Aug. 21, 1900. The accompanying figure shows a side elevation, partially in section, of



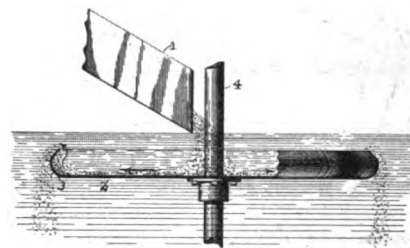
the furnace covered by this patent. The object of the invention is to do away with any mechanical rabblers inside of the furnace for stirring the ore, the ore being stirred and moved along the hearth by means of air blasts. The ore is introduced from a hopper 33, through the

funnel pipe 32, and falls upon the upper end of the hearth. From this upper shelf it is moved to the next shelf by blasts of air from the pipe 26 and from this to the succeeding shelves by successive blasts of air from the pipes shown. When the ore finally reaches the last shelf of the furnace it is thrown into the passage 13 and falls into the chamber 12 from which it is removed. Fire is maintained in the chamber 6, 7 being the grate bars and 8 the ash-pit. The fire passes over the bridge wall 19 and out at the end of the furnace at which the ore enters. The blasts of air not only move the ore, but furnish the necessary oxygen for its oxidation. In order to control the blasts the pipes are provided with valves which are controlled by levers 29. These levers are made heavy so that normally they hold the valves closed. An endless chain 31 is arranged to travel beneath the levers 29 and is provided with dogs 30 which engage and lift the levers, thus opening the valves and causing a series of jets of air to blow across one of the steps in the hearth. By this means the ore is moved slowly down the hearth one step at a time. The air blast is furnished by any suitable blower, as, for instance, 25.

PROCESS OF SEPARATING ORES.

No. 656,728. H. C. ROBINSON, CINCINNATI, O. Patented Aug. 28, 1900. This invention is intended to provide a method for separating gold

from placer material, or any other heavy material from a substance of less specific gravity. It consists of a vertical shaft 4 carrying a horizontal disk wheel 2 having an up-turned flange 3 at the outer edge. The material to be operated upon is fed from the spout 1 on the center of the disk. The disk is placed under water and rotated at such a rate that the centrifugal force will just cause the material to flow towards the circumference. A bank of soft material, such as sand, is maintained against the rim 3 so that any heavy particles such as metallic gold will bed themselves in this bank of soft material and ultimately lodge against the rim, while the lighter material will work up and discharge over the rim.



PATENTS ISSUED DURING SEPTEMBER AND NOT ILLUSTRATED.

- No. 658,407. Casting plant, M. M. Suppes, Elyria, O.
- No. 657,618. Dumping-car, J. B. Rhodes, Harvey, Ill.
- No. 658,435. Coal-digger, W. T. Ginn, Whiteside, Tenn.
- No. 658,291. Blowpipe, F. Speidel, Pforzheim, Germany.
- No. 657,985. Trap-door for mines, A. Hurford, Canton, O.
- No. 658,008. Mining-machine, H. J. Haley, Cardiff, Tenn.
- No. 658,120. Concentrator, J. W. Pinder, Groveland, Cal.
- No. 657,598. Hoist and carrier, C. S. Harris, Rome, N. Y.
- No. 658,653. Puddling-furnace, S. P. Kettering, Sharon, Pa.
- No. 657,628. Filter-press plate, J. E. Turney, Louisville, Ky.
- No. 657,958. Crushing machine, E. Reynolds, Milwaukee, Wis.
- No. 658,071. Crushing-machine, E. Reynolds, Milwaukee, Wis.
- No. 658,281. Machine for treating peat, A. Rom, Lian, Norway.
- No. 657,553. Ore-classifying apparatus, J. S. Loder, Ouray, Colo.
- No. 657,689. Hoisting apparatus, H. C. Behr, San Francisco, Cal.
- No. 657,375. Lead-wire for blasting, W. H. Williams, Concord, N. H.
- No. 658,642. Support for miners' lamps, C. J. Heckel, Pittsburg, Pa.
- No. 658,412. Method of treating ores, G. M. Westman, New York, N. Y.
- No. 658,648. Ore crusher and Amalgamator, L. Jacques, Telluride, Colo.
- No. 657,519. Apparatus for repairing drills, P. L. Crossman, Joplin, Mo.
- No. 658,536. Apparatus for treating ores, G. M. Westman, New York, N. Y.
- No. 658,288. Crusher and pulverizer, T. Shaw and J. C. Lee, Medford, Wis.
- No. 658,330. Hoisting apparatus, H. J. Cook and A. Morris, Boston, Mass.
- No. 658,408. Apparatus for handling and crushing coal, M. M. Suppes, Elyria, O.
- No. 658,656. Dumping mechanism for conveyers, A. L. LeGrande, West Pittston, Pa.
- No. 658,657. Loading mechanism for conveyers, A. L. LeGrande, West Pittston, Pa.
- No. 657,907. Machine for treating peat to be used as fuel, J. Ahrens, Berlin, Germany.
- No. 657,933. Crushing and Pulverizing Machinery, T. R. Goth, San Francisco, Cal.
- No. 657,815. Hoist, Wm. T. Eades and E. Allday, Small-Heath, near Birmingham, Eng.
- No. 657,393. Apparatus for concentrating and separating ores, etc., J. Buss, London, Eng.
- No. 657,181. Process of separating precious metals from their ores, H. de Raasloff, New York, N. Y.
- No. 657,911. Apparatus for separating metals from ores by electricity, G. D. Burton, Boston, Mass.
- No. 657,119. Process of refining copper from solutions containing antimony as an impurity, F. Klepetko and J. T. Morrow, Great Falls, Mont.

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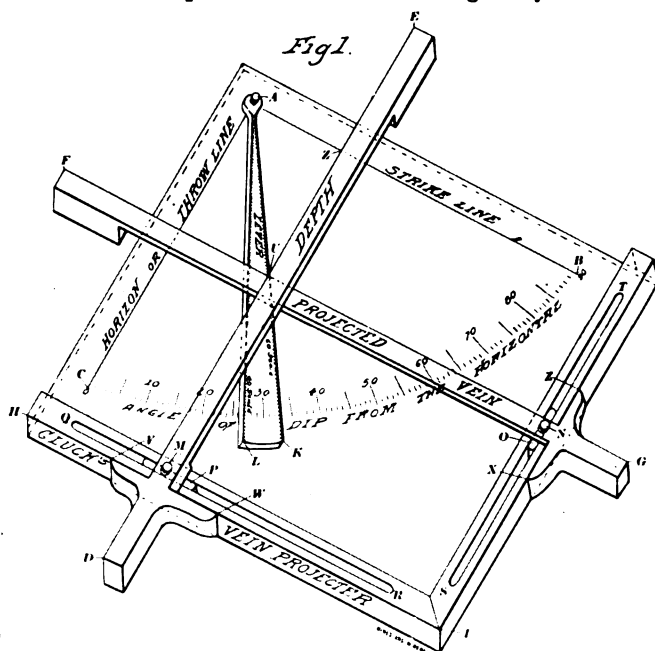
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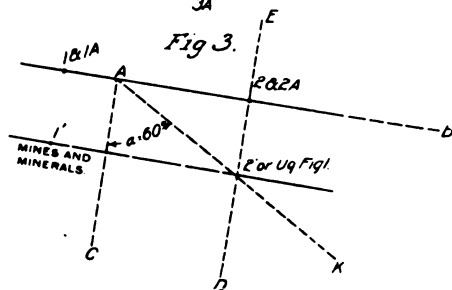
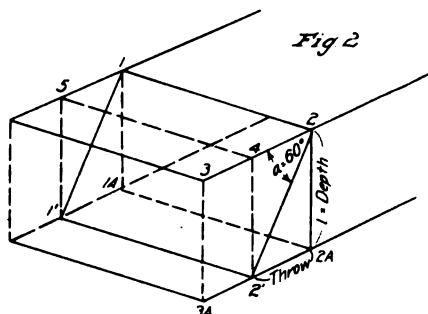
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laying off along AB the distance $22A$ of Fig. 2. Clamp the set screw M ; then swing the lever arm laying off the given dip. Clamp the set screw at A . Find the intersection of DE and the edge AK at U in Fig. 1.

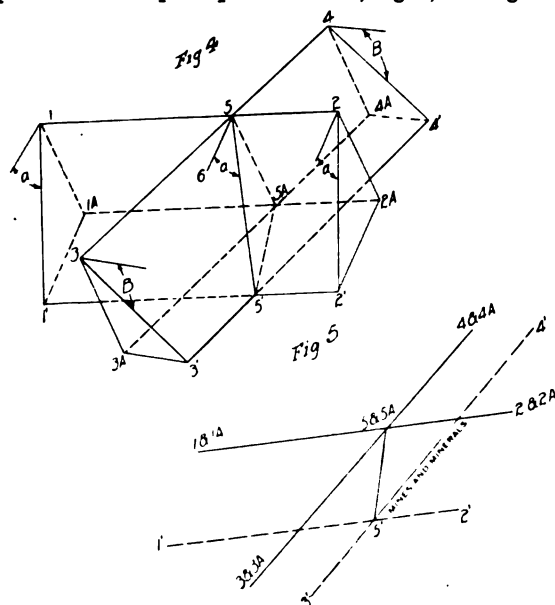
If now the T square FG is moved until its edge FG passes through U , it will then represent the projected vein $1'2'$ in plan.

The next problem is: If you have given on the map the ledge 12 and at a depth $22A$ the projected ledge $1'2'$, to find the angle of dip, as in Fig. 3. Along 12 place AB , then by the lever lay off along



tion of the line of intersection $55'$, and also its direction.

The method is as follows: As previously described, determine from 12 the line $1'2'$ for any depth as $22A$. Then for the same depth from 34 determine $3'4'$. Connect 5 or $5A$ and $5'$, which is the line required. To find the dip of the line $55'$, i. e. the angle $655'$ of Fig. 4, the method is as follows: In Fig. 5, after having laid off on line AB of the apparatus the distance $22A$ by the lever first mark the same by the edge DE of the T square at a point Z . Then place point Z on $5A$, Fig. 5, making ZD coin-



cide with $5A5'$; next swing the lever arm until AK cuts $5'$; clamp screw at A ; read off the required dip on the quadrant. By noting also the distance AU on the apparatus, which is equal to the distance $55'$, Fig. 4, we have the distance along the ledge following along the line of intersection.

The bearing of the horizontal projection of this line of intersection, $5A5'$ can also be read off on the quadrant.

If the problem of finding the line of intersection of two ledges having parallel strikes is required, the method just described must be modified.

Fig. 6 shows two parallel ledges and Fig. 7 the plan of the same. The solution is as follows: Place the line AB of the instrument on ledge 12 in Fig. 7, placing A on point 8 , then draw line 89 , cutting 34 at point 10 . From A lay off the dip a and draw line $8K$; also on ledge 34 from point 10 similarly draw line $10K$ laying off dip B . Find the intersection of lines $8K$ and $10K$ drawing line 56 through this point U and parallel to 12 and 34 . 56 is the horizontal projection of the line of intersection of the two parallel ledges having a dip of a and B .

The determination of lines of intersection of ledges is very important in the study of ore bodies, as usually along these lines there is an enrichment of mineral matter.

In making cross sections of ledges where the section plane is not at right angles to the strike of the ledge, this instrument can be used to advantage; the problem being simply that of finding the dip of the line of intersection of the two planes, one of them being vertical.

For finding the apex of a vein of known dip, the problem is the reverse of the problem solved before, with this difference, however: Instead of projecting down from an upper level, it is reversed. The instrument is reversed from the operation shown in Fig. 2 and Fig. 3.

For tracing the intersection of a vein on its dip with the contours given on a topographic contour map, i. e. to find the apex of the vein, which may be either a straight line or a curved line, the

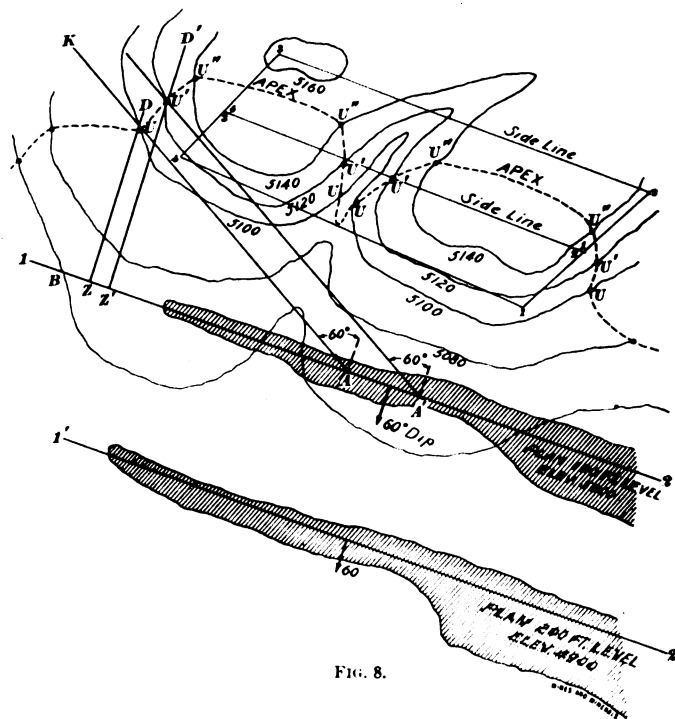
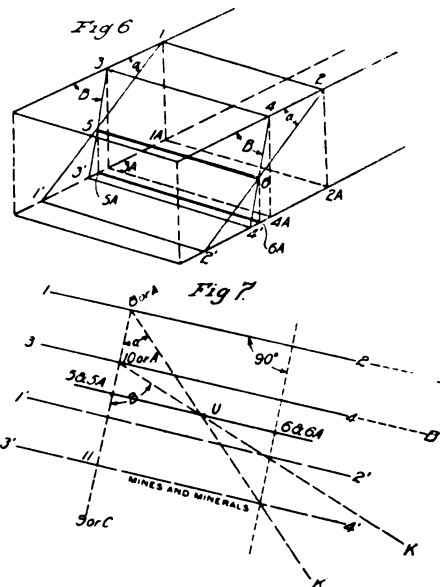


FIG. 8.

operation is as follows: Let 12 of Fig. 8 represent the vein, say at the 100 ft. level, and having an elevation of 5,000 ft. above the sea level, and having a dip of 60 degrees from the horizontal. To find its intersection with the 5,120 ft. contour. Along the strike 12 place the line AB of the apparatus in Fig. 1; by means of the arm AK lay off the vertical interval between the vein at 5,000 ft. above the sea and the contour in question, on the line

AB , moving the T square ED to that point (Z in Fig. 1); then swing the arm AK to read the 60 degree dip. The point of intersection V of the edge AK and ZD is the point where the vein on its dip cuts the horizontal plane having an elevation of 120 ft. vertically above the vein at the 100 ft. level.

By moving the apparatus along the line AB , keeping this line on the strike line 12 , the intersection of the lines AK and ZD with the contour in question determine points on the required apex.

For the determination of the true dip and strike of slightly inclined strata, say a coal seam, with an ordinary compass and clinometer the problem can be quickly solved.

The observations by the compass and clinometer are as follows: From any point A on the strata take a reading of dip α degrees from the horizontal in the direction AB and also its bearing. Then in any other direction AC get the dip β and the bearing. So then the included angle of the bearings is d . If these bearings are plotted on a plan map, the solution is as follows:

With the vein projector along AB measure off the throw AB' for α degrees in 100 ft., and draw a line 12 at right angles to AB' ; similarly on AC for β degrees in 100 and draw line 34 through C' at right angles to AC' .

Find the intersection of lines 12 and 34 at K . AK is the horizontal projection of the true dip line; drawing a line $\perp$ to AK through A represents the strike of the strata. Since AK is the horizontal throw of the true dip line for 100 ft. vertical the angle of dip can be determined by the vein projector, Fig. 1. Make $AZ = 100$ ft., and $UZ =$ the length of the line AK just determined, then swing lever arm (Fig. 1) to the intersection and read the true dip on the quadrant.

For the calculation of the dip and strike of strata cut by vertical bore holes, the preceding problem solved shows the method of solution.

World's Product of Coal.

In the following table is given the coal product of the principal countries for the years nearest the one under review for which figures could be obtained. For the sake of convenience the amounts are expressed in the unit of measurement adopted in each country and reduced for comparison to short tons of 2,000 pounds. In each case the year is named for which the product is given:

THE WORLD'S PRODUCTION OF COAL.

Country.	Usual Unit in Producing Country.	Equivalent in Short Tons.
United States (1899)	long tons 226,558,564	253,739,992
Great Britain (1899)	long tons 220,085,308	246,495,839
Germany (1899)	metric tons 135,824,427	149,719,766
Austria-ungary (1899)	metric tons 87,746,963	41,652,569
France (1899)	metric tons 82,356,104	34,656,426
Belgium (1899)	metric tons 21,917,740	24,159,925
Russia (1898)	metric tons 12,862,038	14,173,960
Canada (1899)	short tons 4,925,051	4,925,051
Japan (1897)	metric tons 5,647,751	6,225,516
India (1899)	long tons 4,208,199	4,707,542
New South Wales (1899)	long tons 4,547,028	5,148,671
Spain (1899)	metric tons 2,742,889	3,022,113
New Zealand (1898)	long tons 906,778	1,015,591
Sweden (1898)	metric tons 236,277	260,448
Italy (1899)	metric tons 341,327	376,245
South African Republic (1899)	long tons 1,907,271	2,136,143
Queenland (1898)	long tons 407,819	454,757
Victoria (1898)	long tons 245,659	275,138
Natal (1898)	long tons 387,811	434,848
Cape Colony (1898)	long tons 171,301	191,857
Tasmania (1899)	long tons 44,141	49,138
Other Countries (a)	long tons 2,000,000	2,240,000
Total		797,062,775
Percentage of the United States		32

a Includes China, Turkey, Servia, Portugal, United States of Colombia, Chile, Borneo and Labua, Mexico, Peru, Greece, etc.

The preceding table shows that the United States has taken first place among the coal-producing countries of the world, our product in 1899 exceeded that of Great Britain, our only real competitor, by 5,494,632 long tons. In 1868 the coal product of Great Britain was 3.6 times that of the United States. In the same year the product of Germany was nearly 15 per cent. larger than ours. In 1871 we passed Germany, leading her in that year by about 10 per cent. In 1875 and 1876 the United States fell back to third place, but took second place again in 1877 and continued to gain in comparison with Germany, until in 1899 the product of the United States was 69 per cent. more than that of her former rival.

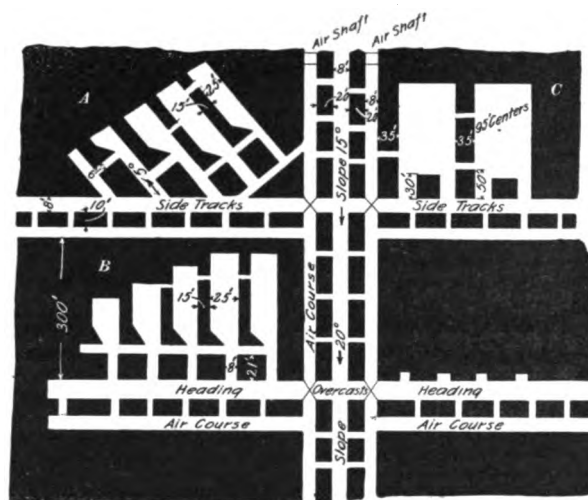
From 1868 to 1878 the product of the United States had increased from 28,258,000 long tons to 51,655,000 long tons. In the same time Great Britain's product had increased from 103,141,157 long tons to 132,612,063 long tons, so that her tonnage in the latter year was not quite 2.6 times as great as that of the United States. In 1888 the output of the United States had risen to 132,731,613 long tons, and that of Great Britain to 169,935,219 long tons, 1.3 times the product of the United States. In 1898 the tonnage of the two countries was, respectively, 196,405,953 and 202,054,516, Great Britain leading the United States by less than 3 per cent. In 1899 the positions held in 1898 were reversed, the United States leading Great Britain by a little less than 3 per cent.

In 1868 the United States contributed 14.35 per cent. of the world's coal supply; in 1878, 18.17 per cent.; in 1888, 28.52 per cent., and in 1899, 31.83 per cent.—U. S. Geological Survey Report for 1899.

Alabama Mining Methods.

Written for MINES AND MINERALS, by J. E. Strong.

The accompanying figure shows the common methods used in working the Alabama coals. The seams now working vary from 2 feet to 6 feet thick, and they pitch from 2° to 40°. Where the seams are thin the coal is hard and pillars of about 20 to 30 feet are used to support the roof. The thick seams are soft and easily broken, and much larger pillars are left. The character of bottom and top varies. Fireclay bottom and slate roof are usually found with the thick seams, and hard bottom and sandstone roof with the thin seams. The general plan of laying out the mine is to drive the slope straight with the pitch of the seam; this is usually on the butts of the coal. A single-track slope is 8 feet wide, and a double-track slope is 16 feet. Cross-headings are driven or turned from the slope water level every 300 feet; air courses are driven parallel on either side of the slope. Where an 8-foot slope is driven 30 feet of pillars are left between the slope and airway, and for a 16-foot slope, 30 feet of pillars. The size of pillars, however, depends largely upon the character of the roof and thickness and strength of coal. On the lower side of the



headings, pillars from 20 feet to 60 feet are left on the entry before turning the first room. The rooms are worked across the pitch on an angle of about 5° on the rail (A), when the coal does not pitch greater than 20°; where the pitch is greater, chutes are worked and the rooms are driven straight up the pitch (B). In a few cases, where the pitch is not greater than 15°, double rooms are worked with two roadways in each room (C). A rope with two pulleys is used and each track keeps the rib side of the room, the loaded car pulling up the empty on the opposite side of the room. Distance between room centers about 42 feet. Where single rooms are worked the room is driven narrow (8 feet wide) for 21 feet, when connections are made with the room outside of it; the room is then widened out to about 25 feet, sloping gradually until this width is attained, pillars of from 10 feet to 20 feet thick are left between the rooms, and crosscuts for ventilation are made about every 50 feet; every third or fourth room is driven through to the entry above; pillars are then drawn back to the entry stumps or pillars. The average cover over the coal now working is from 100 feet to 600 feet. Air courses usually have an area of 30 feet, and sufficient coal is taken out to give this area, the roof and bottom being left.

DREDGING FOR GOLD.

Facts in Regard to the Operation of Dredges on Placers at Various Places in the West.

By W. S. Russell, Chief Engineer Vulcan Iron Works Co., Toledo, Ohio.

Dredging for gold is a new opening for the profitable investment of capital, and it has been demonstrated that under proper management it is a safe business proposition.

The elevator bucket dredge has proved to be the most suitable machine for deep placer mining, and with it ground can be worked that heretofore has been beyond the reach of the ordinary methods previously employed.

There have been but few failures in deep placer dredging, whereas it has been estimated that less than 25% of quartz mining ventures have been successful, and more than 75% have been failures. The reason is plain, in quartz mining you are working in the dark, searching for a hidden vein; signs and indications may seem favorable, but fail in the end after expending thousands of dollars.

In placer mining, however, you can test the ground at a definite expense, knowing beforehand what that expense may be. The "Keystone" driller will put a hole down through the sand and gravel to bed rock at a depth of 40 feet which is about the limit for an elevator bucket dredge. This method is not expensive, and will answer for preliminary prospecting, after which if conditions are favorable, a number of test pits, say 4 ft. by 6 ft. may be sunk to bed rock and every foot of the gravel washed out and its gold-bearing value known.

Not only this, but the nature, thickness, and density of each stratum, whether hard or soft, may be shown, also the proportions of sand, gravel or boulders. These conditions must be known in order to determine upon a suitable style of elevator bucket dredge of proper size and construction, adapted to handle the particular piece of ground under survey in the best and most economical manner.

The best grounds in Colorado, Montana, Idaho, and California lie in the valleys of small creeks and gulches and are universally nearly level. Some are in cultivation, and hundreds of acres of alfalfa, hay and meadow grass are grown on them. The depth of sand and gravel varies from 15 to 30 ft. The bed rock is usually soft, of a clayey nature, sometimes of decomposed granite.

The first elevator bucket dredge operated in this country was built at Bannock, Mont., on Grasshopper Creek, in 1895, by H. J. Reiling and others, was named the F. L. Graves, but was found entirely too light to dig the gravel; it was rebuilt in 1896 and became successful in 1897, earning over \$1,000 per day.

That same year, the dredge A. F. Greater was built and was a success from the start, although a large amount of money was expended in readjusting the machinery to suit the ground, but it proved so rich that it is reported as high as \$5,000 per day was taken out. The company is now wealthy.

Then followed the dredges "Maggie A. Gibson," the "Bon Acord," and the "Geo. F. Cope," all located on Grasshopper Creek, below Bannock. These dredges met with varying success. The "Maggie A. Gibson" ran into poor ground, was finally dismantled and moved to the Ruby Valley, in Montana. The "Bon Acord" was a failure from its conception.

The two miles of creek canyon with 40 ft. to bed rock was too narrow, the bed of the creek was too rough and rocky with huge boulders and cross reefs, to admit of working at all with an elevator bucket dredge.

It must be understood that there was no prospecting of any consequence done in Grasshopper Creek at Bannock, the creek being too wide to admit of test pitting or drilling. Mr. A. F. Greater felt sure there was gold there for he had been there since the early '60's and had seen millions taken out with the rocker and sluice box, in the shallow workings. He secured the most favorable ground and made a fortune.

The dredge "Geo. F. Cope" is now a success owing to the good management of E. L. Hall, Supt., after a year's work in changing and reconstructing the machinery to adapt it to handle the ground in a proper manner.

These particulars concerning the Bannock dredges are mentioned to show the necessity of careful inquiry and study of conditions surrounding a placer property, as well as the systematic and intelligent prospecting.

During the past two years, a number of elevator bucket dredges have been put out and are now under successful operation. The North American Gold Dredging Co. at Breckenridge, Colo., have two elevator bucket dredges, at work in 40 ft. ground. The Boise Dredging Co., of Philadelphia, Pa., have three elevator bucket dredges near Centerville, Idaho, in the Boise Basin, in 28 ft. ground. These are all operated by electric power.

The Horse Prairie Gold Dredging Co. have the new elevator

dredge "Isabel Brenner," in operation at Horse Prairie, Mont., about 18 miles west of Red Rock. The Pacific Gold Dredging Co., of Chicago, have a large elevator dredge near Salmon Creek, Idaho, working on the McNutt placer grounds. The Conrey Placer Mining Co., of Boston, Mass., have a large single lift elevator dredge, working in the Ruby Valley, at the mouth of Alder Gulch, 7 miles from Virginia City, Mont., in 30 ft. ground. The dredge "Maggie A. Gibson" is also working on the Conrey property.

The gold is a medium grade and very evenly deposited. The pay gravel is as yellow as saffron, and very hard to dig. It is also coarse with small boulders.

The Boston and Idaho Gold Dredging Co., of Boston, Mass., has operated a California dredge at Idaho City for the past two years, having met with good success, after the first few months of trial, in 20 ft. ground. They have a small Risdon elevator dredge which does fairly well, as the gravel is small and easy to dig, with a large proportion of sand. A rather remarkable feature of this proposition is that the gold saved exceeds the prospects by about 10%. This company is now experimenting with a large dipper dredge which was started up this spring, but with results as yet undetermined.

There are about fifteen dredges working in California, up the Sacramento Valley, from Folsom, on the Feather River, northward, including the Yuba River, Poker Bar, and Trinity River. At or near Oroville, there are seven dredges, of which five are elevator and two bucket dredges. Most of these are small, of the Risdon type, with buckets of three cubic feet size and 1,000 cu. yds. daily capacity.

It has become evident to all the dredge companies that their machinery is to light and improperly proportioned, and that there is a great expense in making repairs, as the dredges in most all cases are in remote places a long distance from any railroad. In view of this and many other facts, it is evident that there is a necessity for improvements in elevator bucket dredge machinery.

The Vulcan Iron Works Co., of Toledo, Ohio, has had a large experience in this line, dating over several years of very close study of the different requirements in different parts of the West. Not only that but this company has had an experience of something like 30 years building dipper dredges and steam shovels, and has a wide reputation and has the credit of having designed and built the monster 95 ton steam shovel for digging iron ore in the Minnesota mines and others for stripping phosphate grounds in South Carolina, and other states. In fact they build the greatest variety of steam shovels of any concern in the business.

After a close and practical study of the elevator bucket dredge and the subject of placer mining for several years, and after building and operating dredges of both the single and double lift type in Montana, Idaho and other parts of the west the Vulcan company has now designed several styles of elevator bucket dredges on new lines, with new ideas and improvements, and which though being original and simple, embody great strength, as well as ease and economy in operation.

The dredges heretofore built have been fitted with either 3 cu. ft. buckets, having a capacity to dig 900 cu. yds. per day, or 5 cu. ft. buckets having a capacity to dig 2,000 cu. yds. per day of 22 hours.

The new "Vulcan" elevator bucket dredge will be fitted with buckets holding 10 cu. ft. each and have a capacity to dig 5,000 cu. yds. of material every 22 hours. The expense of operation will be but very little more than the old style dredge of less than half the capacity.

This dredge will have about 300 horsepower, will be equipped with the most modern engine power, surface condenser, steel gearing and sprocket wheels, improved steel tumblers and bucket chains, ball bearing grizzly, steel sluice boxes, electric light plant, etc. The hull will be extra strong with water tight compartments, length about 120 ft., beam 44 ft., draft 4 ft. This dredge will have power to handle very hard material and boulders, and will dig the ordinary placer gravel at a cost of 2½c. per cu. yd.

The great aim of the concern mentioned is to obtain a careful survey of the ground to be worked and then build a dredge suitable for the ground, in order to avoid the expense of changing and reconstructing the dredge after it has started to work, which, by the way, is very painful and discouraging to the stockholders.

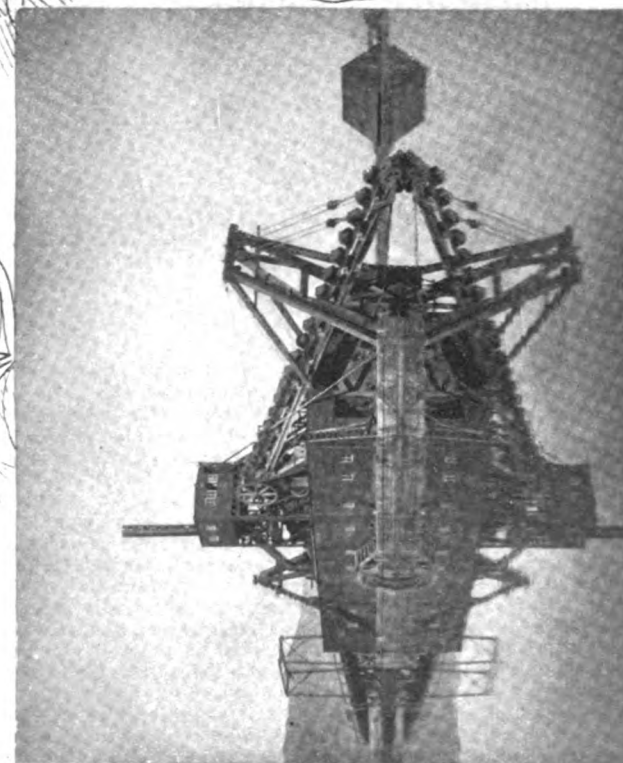
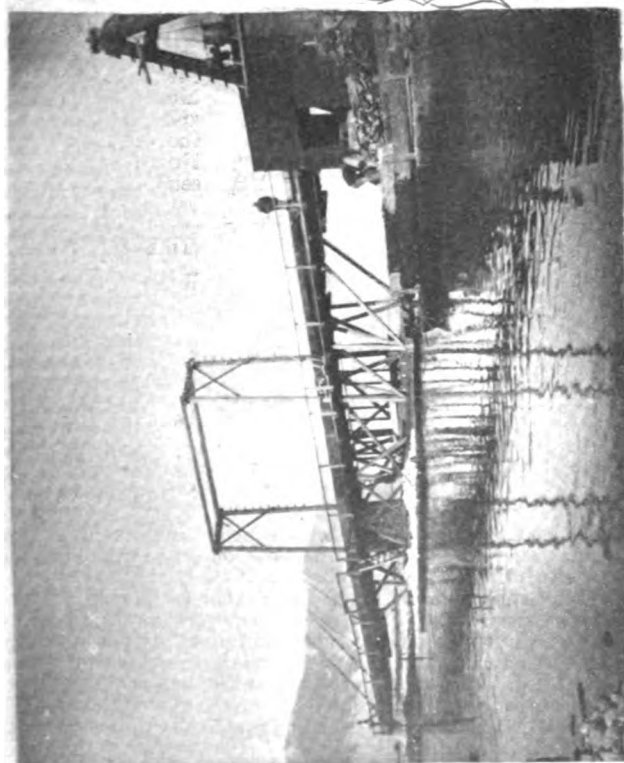
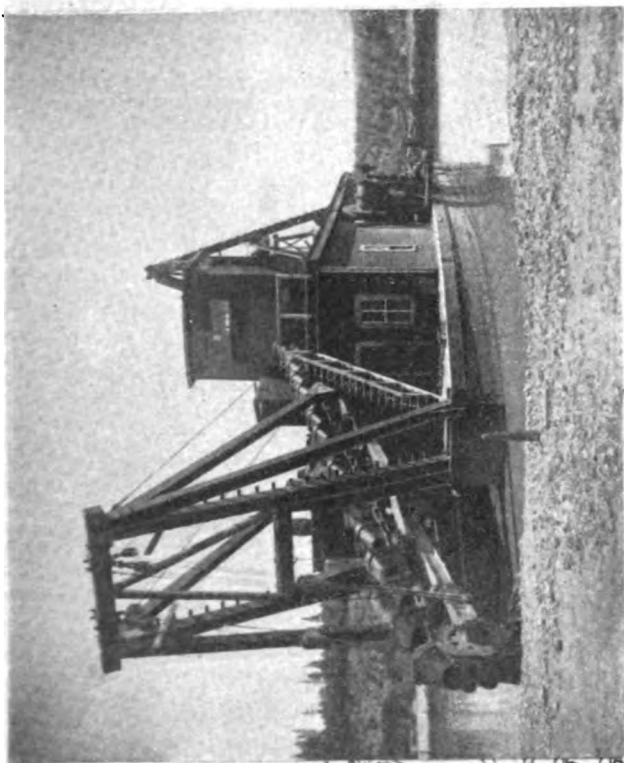
A dredge that will work successfully from the start and produce a daily winning of the golden dust is the one to be greatly prized by those who invest in such ventures.

Profits in elevator dredging depend on the richness of the ground and economy in operation. A dredge handling 2,000 cu. yds. per day of 24 hours at \$1 per yard, will earn \$2,000. There is a big profit in 50c. ground and a good profit in 25c. ground, which would yield \$500 per day. There is plenty of 25c. ground in the west, not being worked at all. The Souther dredge, working near Idaho City, Idaho, is now making over \$300 per day, above expenses. The three Bannock, Mont., dredges "F. L. Graves," "A. L. Greater," and "Geo. F. Cope" have earned from

\$500 to \$700 per day during this season. The Conrey Placer Mining Co.'s dredge "Col. Gordon," in the Ruby Valley, Mont., has earned from \$500 to \$600 per day this season. The Pacific Gold Dredging Co.'s dredge at Salmon City, as well as several

others have been more or less successful, but it is difficult to obtain information as to their earnings.

The following illustrations show typical elevator bucket dredges working under various conditions.



WELSH MINE CARS.

A Detailed Description of Some of the Various Types of Cars in Use in South Wales.

By Mr. J. Fox Talbot.*

The success of a colliery depends upon attention to details, and the faulty design of a mine car or gauge of rails is sufficient in the present time of large quantities and small profits to turn the scales against the colliery proprietor. The object of this paper is not to lay before you a model or perfect tram, but rather to draw attention to the various sorts and conditions of trams prevailing in the South Wales coalfield, and, as these different designs are not called into existence from the different conditions or exigencies of the respective collieries, they cannot all be correct.

The tendency of the age is to increase the carrying capacity and reduce the ratio of weight of car to weight carried, but in some of the most modern cars the latter point appears to have been somewhat overlooked, and it would be interesting to learn wherein the advantages of adopting such a heavy design of car come in. It will probably be argued that the weight is necessary to secure the required strength to withstand the rough usage to which cars are subjected in collieries, and no doubt this is the cause of the existing heavy cars. To add weight to a badly designed car to increase its strength is one way of surmounting the difficulty, but is it the best way? Does not the extra weight cause an inherent weakness in the car itself?

Would it not be better to adopt a car of such a design as would give the required strength without adding to its weight? Having found such a car amongst the existing cars or upon an improved design, would there be any advantage in universally adopting such design, as far as circumstances will allow, at the various collieries?

In the twenty-six cars of which particulars are given in the tabulated statement, representing a fair sample of those used in the larger collieries of the coal-field, the weights of the cars vary from 6½ cwt. to 12½ cwt., and their coal-carrying capacity, allowing for two feet of "topping" and calculating 56 lb. to the cubic

foot, from 24.16 cwt. to 40.64 cwt. (see columns A and B in tabulated statement).

The outside length of cars varies from 69 in. to 84 in.; the outside width varies from 37 in. to 49 in.; the height from rail varies from 29½ in. to 38 in., and the wheel centers vary from 19 in. to 24½ in.

The gauges of the wheels vary from 24 in. to 37½ in., showing sixteen different gauges as follows:—One 37½ in., five 35½ in., two 34½ in., one 34 in., one 34 in., four 33½ in., two 33 in., one 32½ in., one 32 in., one 31½ in., two 31 in., one 30 in., one 29½ in., one 28 in., one 27½ in., one 24 in.

In four cases the gauge of rails is one inch wider; in twenty, half an inch wider; in one, quarter of an inch wider; and in one, one-eighth of an inch wider than that of the wheels.

The diameters of the wheels vary from 12 in. to 17½ in. as follows:—One 17½ in., nine 17 in., one 16½ in., four 16 in., two 15½ in., four 15 in., one 14 in., one 13½ in., three 12 in., or nine different diameters, comprising one "fixed" cast iron wheels, four "loose" cast iron wheels, six "fixed" steel wheels, six "loose" steel wheels, nine "Rowbotham" wheels.

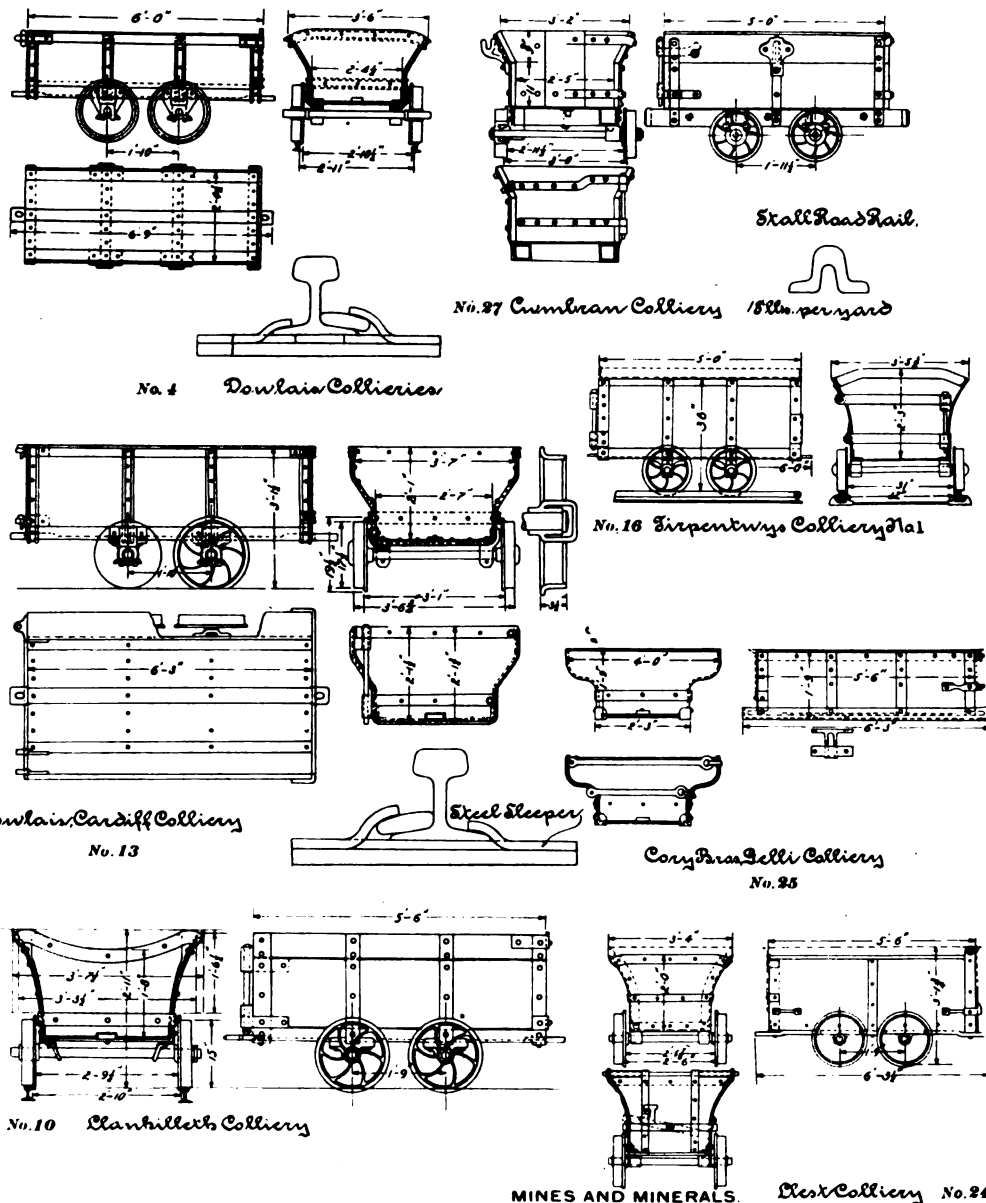
It is interesting to note the different kinds of rails and ties used at the various collieries. The sections of rails vary from 18 lb. to 35 lb. for ordinary roads, and up to 41½ lb. for main roads. There are twelve cases of bridge rails varying from 18 lb. to 24 lb., and twenty-six cases of T-head rails varying from 18 lb. to 41½ lb.

The bridge rails are generally secured to ties with nails, the T-head rails by spikes, and the heavier sections by chairs and fishplates, or spikes and fishplates.

Timber ties are most general, but there are a considerable number of wrought iron and steel of various patterns, and combined ties of wrought iron or steel with cast iron chairs.

T-head rails and combined ties appear to be gaining favor. One advantage of the T-head rail is that you can form your permanent partings at pit bottom and main junctions out of the rails instead of having castings; the former certainly work much smoother and do not wear to the same extent as castings.

Combined ties, of which cast-iron chairs cast on to a wrought-iron or steel tie is a good type, being practically unbreakable and as lasting as the rail itself, have the advantage of maintaining a regular gauge, and reduce the height quite 2 inches as compared with a wooden tie, which makes a material difference in ripping,



DRAWINGS SHOWING DIMENSIONS OF VARIOUS WELSH COAL CARS.

* A paper read before the South Wales Institute of Engineers.

Tabulated Statement, Giving Dimensions and Particulars of Cars Arranged in Order of Ratio of Weight of Car to Weight Carried—as per Column C.

Number.	Name.	Length.		Width.		Height from Rail.		Drawbar.		Gauge.		Wheels.		Rails.		Method of Securing Rails.	Description of Ties.	Cubic Capacity Allowing 2 ft. of Topping.	Weight Allowing 56 Lbs. to one Cu. Ft.	Weight of Car.	Ratio—Weight of Car to Weight Carried.	Number.
		Inside.	Outside.	Inside.	Outside.	Inside.	Outside.	Size.	Sectional Area.	Wheels.	Rails.	Diameter.	Material.	Fixed or Loose.	Section.	Weight per Yard.						
1	Ebbw Vale	63½	72	36	40	34½	24	4 × ½	2	24	24½	12	S	F	T	24	Combined	60.50	30.25	7.25	23.9	1
2	Tirpentwys, No. 2	66	72	35	37	29½	22	3 × ½	1.5	31	32	12	S	F	Bdg.	21	Nails	49.39	24.69	6.25	25.8	2
3	Ferndale A	66	72	43	47	34	22	3½ × ½	2.625	33½	34½	17	S	L	T	22	Flushed and Cramped Nails	64.82	32.41	8.5	26.2	3
4	Dowlais	72	81	39	45½	34½	22	3½ × ½	2.18	34½	35	16½	S	L	T	27	Martin's Patent Steel	64.75	32.37	9.0	27.4	4
5	Cory Bros., Tydraw	72	84	46	48	34½	21	Frame		30	30½	15	S	F	B	24	Dog Nails	78.16	39.08	11.0	28.1	5
6	Nixon's Merthyr Vale	69½	78	41½	44½	37½	22	3 × ½	2.625	33½	34	17	Iron	Fby key	T	36	Nails & Spikes	69.43	34.71	10.0625	28.9	6
7	Cory Bros., Resolven	72	84	46	48	36	21	4 × ½	2.5	33	33½	17	Rowbot	hms	B	24	Dog Nails	79.38	39.66	11.75	29.6	7
8	Lewis, Merthyr	66	74	42	45	34½	21	4 × ½	2.5	34½	34½	16	Rowbot	hms	B	21	Dog Nails	60.59	30.29	9.0	29.7	8
9	Blaenavon, No. 2	64	73	38½	40½	32½	22	6 × ½	4.5	28	28½	16	S	F	T	18	Spikes	48.32	24.16	7.25	30.0	9
10	Llanhilleth	66	76½	41	43½	34½	21	4 × ½	2.5	33½	34	15	S	L	T	25	Combined	62.64	31.32	9.5	30.3	10
11	Powell's Tillery	61	71½	42½	45½	34½	19	3½ × ½	3.0	34	34½	14	S	F	B	18	Road and Dog Nails	57.74	28.87	8.75	30.3	11
12	Great Western	60	69	42	46½	37½	21	4 × ½	3.0	27½	28	15	Rowbot	hms	T	30	Spikes	58.70	29.35	8.928	30.4	12
13	Dowlais, Cardiff	75	84	42	46	37½	22	4 × ½	3.0	37½	38	17½	Rowbot	hms	T	35	Nails	81.28	40.64	12.5	30.7	13
14	Cyfarthfa	64	75	42	46½	37	20	4 × ½	3.5	35½	36	16½	S	L	B	22	Martin's P. S. Wood Steel	60.67	30.33	9.25	30.9	14
15	Newport-Abercarn	63	71½	39½	42	35	20	3½ × ½	3.0625	32½	33	13½	S	F	T	35	Combined	57.35	28.67	9.0	31.3	15
16	Tirpentwys, No. 1	60	72	40½	42	36	19	3 × ½	2.25	31	32	12	Rowbot	hms	B	21	Nails	55.59	27.79	8.75	31.4	16
17	Blaenavon, No. 1	70	79	42	46½	31½	24½	6 × ½	4.5	35½	36	16	S	L	T	18	Spikes	61.43	30.71	10.0	32.5	17
18	Powell Duffryn (New Tredegar)	61	73	41½	45	35½	21	4 × ½	3.5	35½	36	17	Rowbot	hms	T	22	Martin's Patent Steel	64.32	32.16	10.5	32.6	18
19	Ferndale B	66	72	44	47	34	20	4 × ½	3.5	33½	34½	16	Iron	L	T	27	Flushed and Cramped Nails	60.76	30.38	10.0	32.9	19
20	Albion	63½	76	41½	45½	32½	20	4 × ½	4.0	35½	36	15½	Iron	L	B	22	Dog Nails	59.23	29.61	10.0	33.7	20
21	Ocean	66	74½	45½	49	29½	21	3 × ½	2.25	35½	36	17	Iron	L	T	35	Spikes	59.55	29.77	10.17	34.1	21
22	Cwmaman	63	72	42½	45	38	22			34½	35	17	Rowbot	hms	T	25	Nails	63.90	31.95	11.0	34.4	22
23	Powell Duff'n (Ab'r'm'n)	64	73	39½	43½	35½	21	4 × ½	3.5	32	32½	17	Rowbot	hms	B	22	Martin's Patent Steel	60.67	30.33	10.5	34.6	23
24	Llest	66	75½	48	43½	37½	21	4 × ½	4.0	29½	30	16	S	L	T	30	Nails and Spikes	56.41	28.20	10.0	35.4	24
25	Cory Bros., Gelli	66	75	46½	48	31½	21	4 × ½	2.5	33	33½	17	Rowbot	hms	B	24	Dog Nails	65.57	32.78	12.0	36.5	25
26	Gadlys	66	73	37	42	30½	20½	4½ × ½	3.1875	31½	32½	17	Iron	L				52.60	26.30			26
27	*Cwmbran																					27
28	Suggested Design	67	75	42½	46	36	22	4 × ½	2.5	33½	34	15	S	F	T	24	Combined	73.51	36.75	9.0	21.4	28

* Not compared with above cars.

and enables a heavier load to be carried; they are also better for getting cars on the rails when they go off the road. Another advantage is, there are no rails or spikes for the horses to pick up.

Number 28 on tabulated statement and Plan 28 shows a steel car, with a weight of 9 cwt., having a length over all of 75 in.; width, 46 in.; height off rail, 36 in., representing a cubical capacity, after allowing for 2 ft. of topping, of 73.51 cubic feet, or a load of 36.75 cwt., and if built to following specification could be placed on rail at the workshop at \$22.50 per car, and allow a fair margin for profit. This is based upon prices for steel and iron prevailing in 1898. The following are the specifications:

SPECIFICATION.

Back-end binder, 2½ in. × 2½ in. × ½ in.
 Middle binder, 3 in. × ½ in.
 Front binder, 3½ in. × ½ in.
 Buffer plates, 2 ft. × 6 in. × ½ in., secured by ½ in. bolts.
 Top rails, sides, and ends, 2½ in. × 2½ in. × ½ in., special angle.
 Door hinges, 2½ in. × ½ in.
 Side hinges, 2½ in. × ½ in.
 Door pin, 1 in. round.
 Door fastener, 1 in. round.
 Door fastener guide, 2½ in. × ½ in.
 Staple for blocking on, 2½ in. × ½ in.
 Drawbar, 4 in. × ½ in., doubled back at ends.
 Pedestal gland, ½ in. round.
 Frame bolts, ½ in. round.
 Frame sides, ½ in. deep × 3½ in. wide.
 Frame, distant pieces ½ in. deep × 3½ in. wide, tenoned and tusked into sides.
 All of pitch pine.
 Wheels, steel, 15 in. diameter, 2 in. axles, 7 curved arms: width of tread, 2½ in. + flange ½ in. = 3 in. wide.
 Pedestals, cast iron.
 Body of car, drawbar, and pedestals secured to pitch pine frame by 17 ½ in. bolts.
 Rivets, ½ in. diameter.

If design of car 28 is fixed with 12-in. wheels instead of 15 in., which would allow an additional depth of 1½ in. in the body of the car without increasing the height off rail, the load could be increased.

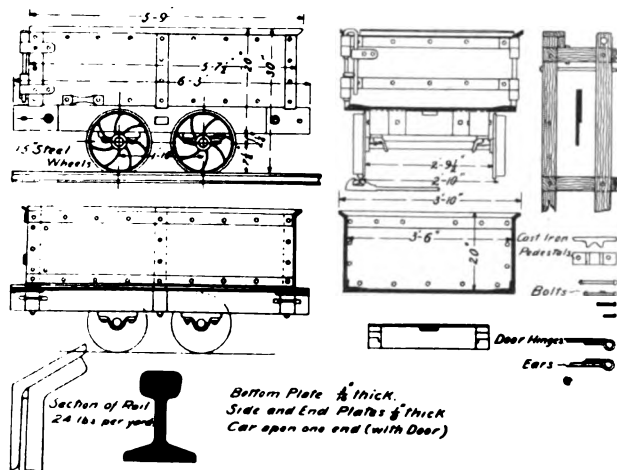
Car No. 1 on tabulated statement is that in general use at the Ebbw Vale Company's collieries. The gauge of wheels is only 24 in., which is an objection, as the horses, especially when first put to work underground, are very apt to tread on the rails, which on a down gradient is a prolific source of accidents; in other respects the car gives excellent results, it runs easy, and keeps the road well, even at high velocities. The life of the car compares favorably with the old-fashioned ordinary iron one, and the cost of maintenance is in favor of the former.

If any particular design of car became practically universal in South Wales the first cost would be considerably reduced, from the fact that, if the various sections and lengths of steel bars and plates were in more general demand, they could be supplied at a lower rate.

A great advantage in the universal adoption of one design of body of car would be that colliery owners could be supplied by the makers with the various sections of bars, angles, and plates to the required sizes, at a minimum price for repairs, which would also curtail the cost of labor in repairing the cars at collieries.

An objection that will possibly be raised to class of car No. 28 is that it is too light or not sufficiently strong to stand the rough usage it would be subjected to in South Wales collieries, but from over seven years' experience that the writer has had with these cars he does not find that they are damaged or entail more repairs than the heavier car. This is accounted for by the car being built to a stronger design, and therefore does not require such heavy

sections of steel as the car in ordinary use; also to the fact of the car having a timber frame, and, being provided with buffers, the bodies of the cars seldom come into collision; the timber frame receives the blow, and if the timber frame is broken, which is very unusual, it can readily be replaced by a new frame and at considerably less cost in labor than repairing a car all of iron or



PLAN 28.—DESIGN OF COAL CAR.

steel, which, if badly bent in a collision, would require to be cut up and rebuilt.

It is usual to keep a few timber frames in stock, on the pit top. The price for fixing a new frame is less than \$.28 per car.

An advantage in this design of car is that the buffers prevent breakage of the coal. When cars come together the force of the blow is largely taken up by the timber frame, and is not conveyed to the coal to the same extent as it is in a car with an iron frame, and especially in cars without buffers, where the coal itself comes into contact.

This design adapts itself better for the use of doors instead of bars at the end, which are often bent and cannot be properly secured, allowing the small coal to get out in transit, which is a consideration, especially in seams where cars have to travel over heavy gradients.

An important point is the weight of a car; for instance, in the case of a system of haulage where it is found that the maximum train conveyed by a hauling engine is at present limited, if the weight is reduced, the journey could be increased, and thus the output of a district probably increased in proportion.

This would depend upon other circumstances as well; at the same time it is not unreasonable to assume such would be the case at many collieries.

A more important point in the South Wales coalfield, where such a large number of horses are employed, is the increased load of coal that would be conveyed by each horse, which represents either an increased output or a reduction in the number of horses.

A train for a horse working on a level is generally regulated by the number of empties the horse can take in rather than by the full load, and an increase of one car in each journey would represent a substantial gain.

The reduced manual labor in dealing with the cars on the pit bank, the pit bottom, and in the stall roads, where miners can and do more readily take their cars from the heading to the face of the coal, would prevent the necessity in many cases of the horses going into the stalls at all.

In collieries where the carrying capacity of the car can be increased a substantial gain would be found from the fact that the miners would still fill the same number of cars, and on five cars would probably send out 10 cwt. more coal, increasing the output 0.25 ton per miner per day. The writer has found from experience that in this way alone it has more than repaid the cost of substituting an improved car, the latter being introduced as renewals were required.

An important point in connection with cars is the lubrication, and fixed wheels offer better facilities for lubricating more effectually and also more economically than loose wheels.

In the suggested design of car No. 28 the gauge of 34 in. and 15-in. wheels are selected because fixed wheels of this diameter are at present extensively used on this gauge in the district and give satisfaction. The writer's experience is in favor of 12-in. wheels, which have always given entire satisfaction and have the advantage of reducing the height of the car or increasing the capacity with the present height.

The question of different gauges and loose wheels need not interfere with the introduction of this design of body of car, as

the width allows for the broadest gauge at present in use, and fixed or loose wheels are optional.

It would be a decided improvement and a step in advance if the cars were supplied with fixed couplings in lieu of chains; it is necessary that the fixed coupling should not in any way interfere with the present drawbar, so as to allow of the free use of shafts or hooks as at present.

The question of ball-bearings for cars is well worth considering, having already been introduced at a few collieries the writer believes with success, and any information on this point will be most acceptable.

The fact of having two different types of cars with different weights in the same colliery should be no obstacle to the introduction of a new car. The writer has had for years three different-weight cars working in the same pit, raising 1,500 tons a day, and no difficulty has arisen.

The chief object of this paper is to draw attention to the advantage of introducing a more universal design of car with a view to economy in first cost and maintenance, and in working generally. It is impossible to adopt one uniform size of car for all collieries, but two or three sizes of similar design of body of car would meet the difficulty, and a considerable advantage would be gained by so doing.

Star Mine Cars.

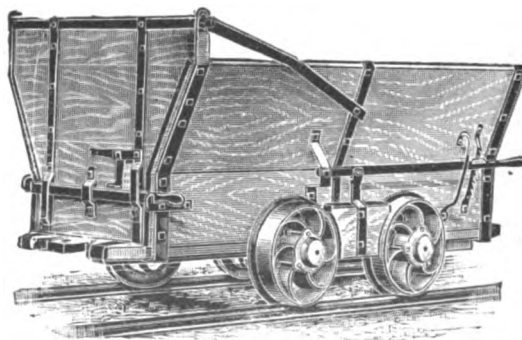
The mine car shown in the accompanying illustration and made by the Star Manufacturing Company, of New Lexington, Ohio, shows very strikingly the general differences in design between American mine cars and English or Welsh as illustrated in the preceding article.

The car here shown is a type very commonly used in the bituminous mines of America, but this general shape and form of construction are modified to suit the ideas of the purchaser.

In the design of a mine car the shape of the body is not so material as the construction of the truck. The wheels and axles of a car and the method of connecting them to the body determine to a great extent the life and service of the car.

It is well known that one great trouble with mine cars is the difficulty in holding the truck solid to the body. The Star Manufacturing Co. claims to overcome this difficulty by its patent truck binders. The axles are held firmly in place by means of cast brackets and wrought iron binders, so that the truck is perfectly rigid, independent of the body of the car, and by this arrangement the wheels are always in line, causing the car to run true on the track, and preventing the binding of the wheels that will always occur when the axle gets loosened from the body. A round steel axle, which passes through the brackets is used and these brackets and binders are firmly bolted to the bottom of the body, the bolts being so distributed that it is next to impossible for the truck to become loosened from the body, and if it does the wheels still remain in line with each other, so that they will still run true on the track. An oil pocket and waste keep the axle oiled and cause it to turn easily in the bracket.

Another important feature of this truck is the wheels. The self-oiling device will be found an effective oil saver. In the rear part of the hub there is a groove which catches the oil as it works back to the collar of the axle and this prevents the oil from passing out. In this groove are four holes connecting it with the oil chamber, thus furnishing oil at both ends of the spindle. On the front of the wheel is a cap with oil hole in the center, through



STAR MINE CAR.

which the wheel is oiled. This cap is held in place by three bolts and is made oil tight by means of a rubber gasket. This cap does not project out from the body of the wheel so as to be liable to be broken. This wheel is made with or without a sleeve to fit over the axle. When without sleeve the wheel turns directly on the axle. When used with sleeve, the wheel turns on

the sleeve, which is held firmly to the axle by the linch pin, and when worn on the under side can be turned over, making it as good as new. The wheels are cast in chills on the wearing surface only.

The Star Company builds these cars in any pattern of body desired, with either swing or lifting end gate. It also builds cars with the common square axle, using the same wheel, either with or without the sleeve. Where brakes are wanted the single block brake shown on cut of car is usually put on. If brake is wanted on both sides of car, a rocker bar under the car and but one lever is used. If preferred, a double block brake can be put on both sides the same as in the single block.

The Star Company will be pleased to furnish estimates on cars complete, on trucks only, on car irons, bent and punched, and on mine castings of any kind, on receipt of specifications, and will furnish blanks, conveniently arranged for filling out sizes and dimensions of what may be wanted.

The Use of Light in Mines and Factories.

Incandescent lamps are used to create artificial light to render objects visible to the eye when natural light has ceased to render them visible. The primary law of vision may be said to be in substance that objects are made visible by light rays reflected from the object to the eye of the observer; hence, we may say that the useful light given out by any source of light is that portion which strikes the object that you wish to see. For this reason, the most efficient lamp for any particular purpose is the lamp which best renders visible the objects you wish to see.

This statement scarcely admits of controversy, and the next point to be considered, therefore, is the location of the object which you wish to render visible. Conditions, of course, vary in this respect; in reading, the paper is held below the eyes, in writing the same is true, and in working at almost any kind of labor, the objects you wish to illuminate are usually below the level of the eye. It is generally known and admitted that reflected light only should reach the eyes, and hence the source of illumination should be placed so as to throw the light upon the page or object to be illuminated, but so that it will not shine directly into the eyes of the observer. These two facts being admitted, that most of the objects to be illuminated are below the line of vision, and that the source of illumination should not shine directly into the eyes of the observer, it follows naturally that the source of light should almost invariably be placed above the line of vision. About the only instance where the source of light is in line with the eye is where lamps are used for signs or signals.

Since light rays travel in straight lines, the light that strikes an object directly beneath a lamp must be emitted through the tipped end of the bulb. Therefore, the lamp that is so constructed as to give a maximum of light through its tip end, produces the greatest amount of useful light, in the sense that the term "useful" applies above.

While to the ordinary observer there is scarcely any noticeable difference in the amount of available light given by incandescent lamps, yet to those who have studied the question, there is a considerable variation in economy in the lamps of different manufacture.

The Shelby Electric Company, of Shelby, Ohio, has paid particular attention to the subject of securing the greatest amount of useful light from its lamps, and experiments carried on by scientific investigators in different parts of the country show that great

success has been attained by this company along this line. This company has developed an incandescent lamp which has peculiar advantages for the use of mines. Some of the points considered of practical value about this lamp are the following: (a) The distance between the terminal points; (b) the leading in wire is insulated in such a manner that dampness cannot effect it, consequently the life of a lamp is very much longer and the economy thus effected is very important; (c) the tip is protected by the base so that it cannot be broken; (d) the lamps are made to fit any system, any voltage, and any base; (e) the carbons do not sag, regardless of any position; (f) this lamp throws twelve and sixteen candlepower sidewise as against four to seven candlepower of some other makes. This is accomplished by the style of filament used and which is certainly most advantageous for producing useful illumination.

This lamp is built especially so as to not require the aid of white walls to add to its reflecting powers; hence the black walls of the mine are no detriment and the amount of available light for actual use is much greater than is ordinarily obtained.

In a pamphlet entitled "Lamp Efficiencies," the Shelby Company has given some very useful information, which will be sent free to any one who wishes to investigate the matter more thoroughly.

Peculiarities of Siberian Placers.

The great extent of the regions covered with auriferous alluvia in Siberia is undoubtedly the primary cause of the difficulty experienced in examining them systematically. The impenetrable virgin forests at the north, with their luxurious vegetation, fallen trees, and, above all, marshy soil, prove an obstacle to geological research. It is impossible, in the majority of cases, to follow the different strata, recognize outcrops, or ascertain the nature of the subsoil.

It was not until 1886 that the want of a school of geology at Irkutsk made itself felt, although as far back as the year 1843 the department of mines had sent Colonel Hofman to Siberia to study the gold deposits.

The information obtainable on the subject of Siberian placers is consequently scattered through a great number of monographs, and until the geological committee of the Great Siberian Railroad publishes the result of their labors, it will be difficult to treat the subject comprehensively. In contrast with the great strata of the Rocky Mountains in California and in British Columbia, which belong to the Pre-Tertiary period, as attested by the volcanic matter with which they are covered, the alluvia of Siberia belong to the Quaternary epoch and are of recent formation.

Siberian placers are situated in valleys having usually a gentle fall and often marshy. Their distinctive feature is that the pay gravel above the bed rock is covered, in the immense majority of cases, with an unproductive layer of soil.

Auriferous localities are also generally characterized by the presence of low, rounded hills testifying to the intensely destructive action of the atmospheric agents upon the rocky conformation of the country. The placers are found at a moderate altitude above sea level. In the Urals, they are met with at a height varying from 500 to 1,000 feet; in the Alatau Mountains, at 2,000 feet; in the valley of the Olekma, from 2,000 to 2,500 feet; and in the Yenisei, from 2,500 to 3,000 feet.

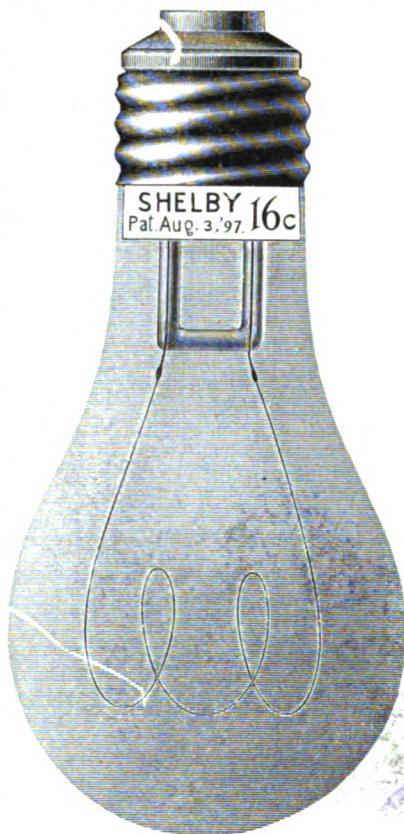
In addition to the native gold, frequently found in nuggets, iron pyrites, often in the form of mispickel, and all the products of its decomposition, such as magnetic oxide, limonite, hematite, etc., are met with in Siberian gravels. Copper is found, sometimes native, sometimes in the form of copper pyrites; lead has been discovered as sulphate, carbonate, phosphate, or sulphuret. Native bismuth has been found in the valley of the North Yenisei and in certain valleys of the Altai. Among hard stones, garnets, rutile, tourmaline, zircon, peroxide of tin, etc., are found.

The organic remains are most generally those of the mammoth. In 1840, it was calculated that more than 2,000 of these animals were found; some, with portions of their bodies still soft, were discovered in the frozen clays of the extreme north. The woolly rhinoceros (*Rhinoceros tichorinus*) is also frequently met with.

The state of preservation of these mammoths—animals which required abundant vegetation—indicates in a striking fashion the rapidity with which the Glacial period must have enveloped the vast plains of Siberia.

Human remains have also been found—a skull at a depth of 10 feet in the Chtogolev mine in 1860; ancient hearths; also a stone slab, with inscriptions, in a mine in the basin of the Kigas.

A feature altogether peculiar to the Siberian placers, especially those in the district of the Lena, Zeya, etc., is that the soil remains perpetually frost bound or thaws only slightly in the summer time. Near the sources of rivers places are found not frozen; these are said to be caused by warm or tepid springs beneath the surface of the earth.—U. S. Consular Report. Translation from book by Baron de Batz.



NOTES ON HYDRAULIC MINING.

Practical Points Necessary to Be Considered in Carrying Water in Ditches, Flumes, Etc.

By George H. Evans, C. E., M. E.*

There are many points in hydraulic mining on which a mine manager or superintendent should be posted.

1st. Water Facilities. Methods of measuring the average amount of water available the season through for working claims.

2d. The nature of the country through which the ditches, flumes and pipe lines have to be constructed to carry water for mining purposes, and different grades suitable for such purposes. Ditches have been constructed for long distances with too heavy a grade and so the water acquired too much velocity and completely washed away the greater portion of the ditch. Again ditches have been constructed with too little grade, and cases have occurred where ditches have been made with the fall in the wrong direction.

3rd. The quantity of water different size pipes will carry or that can be discharged through pipes and nozzles under various heads.

4th. The friction caused by using pipes of too small diameter, and loss of head due to this, also loss of head due to bends of short radius and angles of all kinds in pipe lines.

5th. A knowledge of the different motors used in connection with hydraulic mining and of the various kinds of water wheels.

6th. Strength of material, chains, hemp, manilla, wire ropes.

7th. Bursting and working strain of iron and steel pipes of different diameters. Strength of iron and steel plates, single and double rivetted with punched and drilled holes.

8th. Methods of economically treating alluvial deposits in large quantities when there is not sufficient grade for ground sluices, and yet enough for piping or in cases where, owing to the law, it is necessary to impound the tailings.

Water Facilities. Great care should be taken in arriving at the average quantity of water available all the year or during the entire season, so that sluicing can be carried on continuously. To do this creeks or streams must be measured at different points to approximate the average supply of water that can safely be relied on from such source, allowance being made for evaporation and leakage which in cases reaches 20 per cent. A simple method of measuring the quantity of water flowing in a stream is as follows: Measure depth of water in feet at 6 to 12 points across stream at equal distances, do this in two or three places along a fairly straight course, add all depths together, divide result by number of measurements taken. This will give the average depth of stream and such depth multiplied by average width in feet, will give its cross section or area in square feet, which multiplied by the velocity of water in feet per minute gives the number of cubic feet flowing per minute in the stream.

To find velocity, step or measure off 120 feet along the bank, and to allow for surface of water flowing faster than bottom or sides and thus obtain mean velocity, call the measurement 100 feet and at the commencement of this 100 feet throw into the middle of the stream pieces of paper at intervals and note the time

it takes each to reach the end of the measured line. Then divide the total time in minutes taken by all the floats by the number of floats, and the result will be the average time taken for each float to make the trip. Divide average time in minutes by distance in feet, viz.: 100, and result will be velocity in feet per minute, and this multiplied by the area in square feet will give the number of cubic feet flowing per minute, or if the answer be required in miners' inches, multiply the cubic feet per minute by 2 and divide by 3.

Nature of Country for Grades.—This must be considered in connection with ditches or flumes in order to establish the correct grade upon which depends the velocity or destroying force of the water, and in locating the sites for water races.

1st. Ascertain by aneroid the lowest point in stream or water supply that will allow sufficient grade for conveying the water to a point suitable for working claims, and if the maximum supply obtainable is less than required for advantageous working, then favorable sites must be located for construction of storage dams or reservoirs capable of storing sufficient to keep up the required supply.

2nd. Should the lowest point in the stream contain more than enough to meet the requirements of the mine or mines in driest season, then the locator should select the greatest elevation that the country through which the ditch has to be constructed, and the water supply available at driest season will allow, so that the ditch when completed will command the largest area of mining ground, with the maximum head of pressure. Ditches have been

constructed to command large tracts of mining ground and found to have tapped the source of supply at such an elevation that it was impossible except in the wet season to get sufficient to work with.

3rd. All timber line along the ditch should be curtailed and when fluming cannot be avoided, iron or steel should be considered for permanent ditches, the durability and great saving in cost of maintaining, more than compensates the owner of the ditch. In case of necessary timber work, the most durable should be chosen and coated with asphaltum or mineral paint.

4th. Line of ditch should be laid out as short as possible and in coming around long points or in places where sidelings are very

steep and of loose rocks tunneling through spurs should be considered, or when tunnels can be constructed without timbering they should be preferred to long ditches around such spurs or points unless ground for ditching is exceedingly good and extra distance quite short.

5th. Along the line of ditch, springs or water courses should be connected by means of short flumes or ditches that the loss of leaks and evaporation from main supply will be entirely or partly made up. By-washes or water gates should be constructed in case of sudden increase of water from rains or melting snow.

At different points along line of races where fluming is necessary allowance should be made for an increase of grade in order that the flume can be constructed of much smaller dimensions than the ditch and yet carry all the water required. The least amount of friction in ditches and flumes is developed when the least wetted border is obtained, and to do this the width of the bottom must be from $1\frac{1}{2}$ to $2\frac{1}{2}$ times the depth of the sides.

In constructing tunnels when they will stand without timbers the Gothic arch is best, as it stands better than the circular, or any other kind of roof and does not flake. Tunnels constructed with circular roof have flaked off naturally till they have assumed the section of a Gothic arch.



EXAMPLE OF SLUICES, CALIFORNIA.

*These notes will be found very much amplified in the author's work entitled "Practical Notes on Hydraulic Mining," published by John Taylor & Co., San Francisco, Cal.

Grades and Capacity.—The character of the ground through which a ditch is made bears on the grade required. In ordinary ground water should travel at rate of 180 to 200 feet per minute. The grade then will be determined by dimensions of ditch and its intended carrying capacity.

Races through which water flows at too high a velocity through ground of a porous nature will never be free from leakage, because the velocity of the water will not allow sediment to settle, and sediment traveling with water at moderate speed is relied on to tighten up portions of the ditch cut through ground of a porous nature, and again if velocity is too high it scores holes in the bottom and sides of ditch when constructed in sandy or clay soils. When owing to weak banks it is necessary to build walls on the lower side of a ditch, the ground should be removed to obtain a solid foundation and two walls an outer and inner, should be built up with space enough between to allow a good puddle clay to be rammed in, such a wall if properly constructed will never give further trouble.

All earth, trees, roots, must be moved quite clear of the lower side of the ditch with the exception of just sufficient to make a track, otherwise slides are apt to occur.

At entrance of tunnels and commencement of flumes and at points where velocity of water is retarded the effects of water changing its form at such places must not be neglected.

To find area of section of flume or ditch with straight sides, multiply width of bottom in inches by height of sides in inches. The product will be area in square inches and this divided by 144 gives area in square feet.

Carrying Capacity of Pipes. Discharge of Nozzles, etc.—Pipes



EXAMPLE OF SLUICES, BRECKENRIDGE, COLO.

and nozzles are of great importance. The pressure of water is only as the head without regard to size of pipe. A pipe line of 6 in. pipe and another line of 40 in. pipe with same fall or head will both give the same pressure. Miners have been known to ask if the pressure could not be doubled by doubling the diameter of the pipe.

The principle of hydrostatics in building storage dams and reservoirs should be understood, remembering that there is the same pressure on the bank of a reservoir with water three feet deep and extending back for a distance of 10 feet as there would be if the water dammed back 10 miles, so long as the depth remains the same.

Nozzles require great care in construction, to be correct of form in order that water leaving them will be in solid stream instead of scattering and thus losing its power which is the case with nozzles of improper construction. To get the best effect it is necessary that the head of the pipe conveying the water should be three or four feet under water to prevent air getting into the pipe causing water to scatter when leaving the nozzle.

Water issuing from a nozzle should attain the height of the head. A nozzle with 300 feet head should throw a stream a height of 300 feet, this however, cannot be attained in practice owing to the resistance of the air.

All pipe lines should be laid as straight as possible or with curves having as large a radius as can be obtained, and new pipes well coated will carry more water than old pipes rusted inside. Allowance must be made accordingly. It is well to allow $\frac{1}{4}$ diameter of pipes under 6 inches and 1 inch on all diameters over 6 inches.

First the fall available for the pipe line must be ascertained

and its length in feet. Knowing this and the quantity of water that is to be used, it is easy to determine the diameter of pipe. Water should flow in pipe at velocity of not more than 3 feet per second.

Friction in Pipes.—When large quantities of water are discharged from pipes of small diameter the pressure is greatly reduced. Errors are made in bringing water supply to claims and laying down pipes of too small diameter, thus reducing the effective head or pressure to less than one-half that available with pipe lines properly constructed.

Water flowing through pipes should not exceed 3 feet per second or 180 feet per minute, and if users of water for hydraulic purposes had their pipes of the correct diameter to insure velocity not exceeding that named above, there would be little trouble. The friction of water in pipes increases as the square of the velocity and depends on the condition of the pipes, whether they are foul and rusty, new, or in good condition. Even the rivet heads in a pipe line of considerable length cause a good deal of friction and loss of head. Loss of head is also due to bends and angles. This is sometimes great owing to the number of sharp bends or changes in the direction of a pipe line. In a pipe line there should be no bends having a radius of less than five diameters.

Considerable space is given by Mr. Evans to strength of material which we must omit here for lack of room and turn to methods of treating alluvial deposits in large quantities where sufficient fall is not available, sluices, grades, etc.

Grades and Sizes of Sluices.—A wide sluice will carry more material and save more gold with considerably less grade than a narrow and deep one.

In gold saving there should be as thin a film of water and material in the sluices as possible. There must be just sufficient water, however, to cover the largest stones sent down the sluice.

As to the grade of sluices, with a grade of 1 in 20 to 1 in 25, 40 miners' inches or 60 cubic feet per minute will wash from 140 to 170 cubic yards per day of twenty-four hours, and with light grades the depth of water in sluices must be as shallow as possible, just so that it will move the largest stones and prevent the sand from packing.

When there is a large proportion of heavy stones the best results are obtained by having about 10 to 12 inches of depth of water in the sluice, assuming that the large stones are not over 10 to 12 inches diameter.

Rank of Coal-Producing States in 1899.

The amount and value of product, and percentage of each State is given as follows by Mr. E. W. Parker.

1899.

Production.				Value.			
Rank.	State or Territory.	Amount.	Per Cent. of Total Product.	Rank.	State or Territory.	Value.	Per Cent. of Total Value.
1	(Pennsylvania: Anthracite..	Short tons. 60,418,205	23.8	1	(Pennsylvania: Anthracite.	\$48,142,130	34.4
2	Bituminous..	74,160,175	29.2	2	Bituminous..	56,247,791	22.0
3	Illinois.....	24,439,019	9.7	3	Illinois.....	20,744,553	8.1
4	West Virginia..	19,252,995	7.6	4	Ohio.....	14,361,908	5.6
5	Ohio.....	16,500,270	6.5	5	West Virginia..	12,058,268	4.7
6	Alabama.....	7,538,416	3.0	6	Alabama.....	8,256,462	3.2
7	Indiana.....	6,006,528	2.4	7	Iowa.....	6,397,338	2.5
8	Iowa.....	5,177,479	2.1	8	Colorado.....	5,363,667	2.1
9	Maryland.....	4,807,896	1.9	9	Indiana.....	5,285,018	2.1
10	Colorado.....	4,776,224	1.9	10	Wyoming.....	4,742,525	1.9
11	Kentucky.....	4,607,255	1.8	11	Kansas.....	4,478,112	1.8
12	Kansas.....	3,852,267	1.5	12	Maryland.....	3,667,066	1.4
13	Wyoming.....	3,837,392	1.5	13	Kentucky.....	3,618,222	1.4
14	Tennessee.....	3,330,659	1.3	14	Washington....	3,608,969	1.4
15	Missouri.....	3,025,814	1.2	15	Missouri.....	3,591,945	1.4
16	Virginia.....	2,106,791	0.8	16	Tennessee.....	2,940,644	1.1
17	Washington....	2,029,881	0.8	17	Montana.....	2,847,757	0.9
18	Indian Ter....	1,587,427		18	Indian Ter....	2,199,785	0.9
19	Montana.....	1,496,451		19	New Mexico....	1,461,865	
20	New Mexico....	1,050,714		20	Texas.....	1,334,896	
21	Texas.....	883,882		21	Virginia.....	1,304,241	
22	Arkansas.....	843,554		22	Utah.....	997,271	
23	Utah.....	786,049	3.0	23	Arkansas.....	969,388	
24	Michigan.....	624,708		24	Michigan.....	870,162	3.1
25	Georgia.....	a 260,007		25	California.....	b 430,636	
26	California.....	b 160,972		26	Georgia.....	a 264,309	
27	North Dakota..	98,809		27	Oregon.....	260,917	
28	Oregon.....	86,888		28	North Dakota..	117,500	
	Idaho.....	20			Idaho.....	100	
Total.....		253,739,992	100.0	Total.....		256,077,434	100.0

a Includes North Carolina.

b Includes Alaska.

THE GREAT LONDON FAULT

Of the Mosquito Range and the London Mine—An Illustration of the Evolution of a Fault.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

All miners both coal miners and metal miners are interested in faults, often painfully so.

We have lately in the Mosquito Range, South Park, Colorado, had an opportunity of seeing in a remarkable and picturesque way a great fault in all its phases of evolution. We have also met it as an important factor in a noted gold and silver mine of that region. The fault in question is called the London Mine fault, because it passes in close proximity to the London Mine on London Hill, between North and South Mosquito ranges. The fault cleaves the Mosquito Range, which lies between South Park

faults resulting from lateral or tangential pressure at right angles to the axis of the range. The range is folded up like sheets of paper or cloth. Beginning on the south we find the great steep fold of Sheep Mt. which mountain owes its shape to its folded structure. On the steep face of Four Mile Cañon the whole anatomy of the mountain is clearly shown and the steep arch appears in all its ideal symmetry and perfection. Granite forms the base of the mountain, and over this bends the arch consisting of Cambrian quartzites below, with Silurian and Carboniferous quartzites above, with a sheet of white porphyry capping the summit.

The course of the fault is shown in the profile of each mountain by the deep notch it makes in its outline. This is seen here between Sheep Mountain and Lamb Mountain west of it. The latter mountain is capped by a heavy bed of porphyry, the rest of Lamb Mountain is composed of Weber grits of the Middle Carboniferous, relics of which are found on the top of Sheep Mountain, showing that they have slipped down in Lamb Mountain over 1,000 feet, the amount of slip is about 2,000 feet.

Some of the strata of the S fold are thrown up on edge at point B on Lamb Mountain near the fault. Here and in each cañon where the fault is known to exist, the exact fault line or line of fissure is entirely obscured as is commonly the case with great faults by fallen masses of debris. The zone of the fault line is also characterized by a good deal of coloring matter of iron oxide. Nature it would seem likes to conceal her faults. It is only in mines or where the debris or vegetation is removed or washed away clean by the action of the sea or some other body of living water that we can get a chance of seeing the exact line of the fault fissure. The next most striking appearance of the

fold and fault as we follow it north from cañon to cañon is in Sacramento cañon. There we observe another symmetrical arch, but flatter than that of Sheep Mountain, though on its west side it bends down quite as vertically towards the fault line. On the west side the lines of folding and bending down towards the fault are beautifully shown in graceful lines of curvature among the turf-covered rocks.

and Leadville, from end to end for a distance of some twenty-five to thirty or more miles.

The Mosquito Range consists of a series of Paleozoic quartzites, limestones and intrusive sheets of porphyry, folded and faulted. These strata, forming the floor of the basin of South Park, are folded up on the west into the Mosquito Range, which like a breaking wave, overhangs one side of the great Valley of the Arkansas, in which Leadville is situated. On the east side the strata rises gradually into a lofty arch or anticlinal fold of at times wonderfully perfect and symmetrical shape underlain by granite. This S fold on reaching too severe a strain of tension broke down into the London fault. The same compressive movement that seems to have been laterally squeezing the strata up against the unyielding mass of the Sawatch Range west of it caused also other minor folds, which similarly broke down into faults with out in many cases showing any sign of the arch or fold, from which they broke, not any sign of a fault scarp or cliff. All these signs have been removed by erosion except in the case of the London fault, where the fold that preceded the faulting is beautifully shown on the walls of each successive cañon cutting the range. The accompanying diagrams will show the wonderful symmetry of these arches, often as perfect as those of masonry. Owing to these successive step faults we descend to Leadville on the west side of the Mosquito Range by a series of gigantic steps.

In the North Mosquito amphitheater, near the York mine, appears to be the relic of a fault scarp or cliff such as is not often seen in faulted ground, such cliffs or scarps being generally removed by erosion. The fault shows in a remarkable manner how folds by extreme tension snap and pass into faults. To the south the folding and faulting die out in a rounded hill, known as "Round Mt." To the north the dying out of the fault is not known; by some it is said to extend as far as the mining district of Kokomo which would make the extent or length of the fault fracture upwards of 50 miles.

The Mosquito Range is also a typical example of how certain mountain ranges are formed by simple or complicated folds and

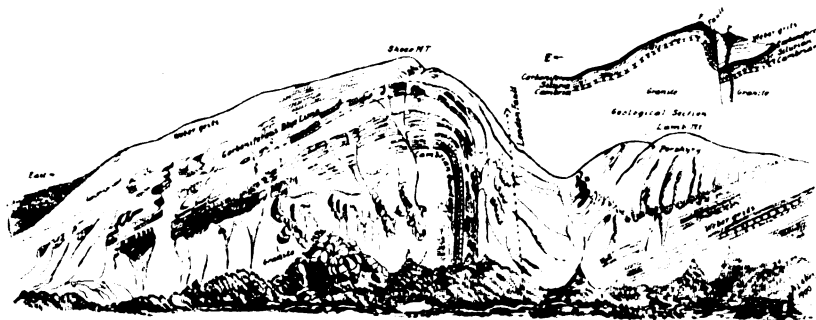


FIG. 1.—THE LONDON FOLD AND FAULT ON SHEEP MT., FOUR MILE CANON.

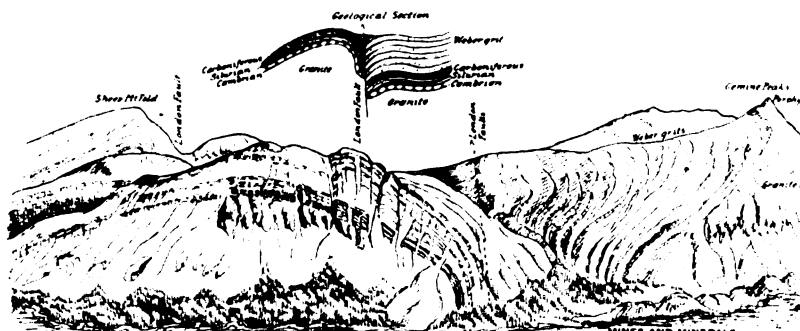


FIG. 2.—THE SACRAMENTO ARCH AND LONDON FAULT, SACRAMENTO CANON.



FIG. 3.—LONDON FAULT ON SOUTH FACE OF PENNSYLVANIA HILL.

In the next cañon of Big Sacramento we lose all signs of the arched structure. We can only recognize the evidence of a great fault by Cambrian quartzite resting on granite forming one side, and terraced lines of outcrop of Middle Carboniferous Weber grits forming the other or west side with a huge swath between them of gaily colored debris obscuring yet indicating the general line of the fault fissure. The fault is somewhat similarly shown on Pennsylvania Hill. At the top of the hill, presumably near or close to the fault line, a prominent knob occurs of quartzite which has been highly colored by iron oxide and shows on its east face a complete metamorphism into cavernous quartz.

From Pennsylvania Hill we cross the next gulch to London Hill, where the celebrated London Mine is located in close proximity to the line of fault. The general direction of the fault is N. 15° W. to N. 45° W. The line is not quite straight, its average may be N. 30° W. or N. W. magnetic. The great S fold everywhere close to the fault has the same direction. The fault cuts this fold, now in one part, now in another, west of the anticlinal axis.

We now approach London Hill itself from the south, and we observe that this hill consists of two parts, one of solid granite on the east with stratified Paleozoic rocks on the west, the division is caused by the London fault which cleaves the hill in a general N.W.-S.E. direction. The line of the fault on the south side is only shown by the broad swath of detritus between the two formations of the stratified rocks and the massive granite; on the opposite or North side of the hill the division is somewhat more clearly shown. It is on this side at the base of the hill that the London Mine is located.

The Paleozoic strata dip easterly towards the fault on London Mountain at an angle of about 25 degrees, but when they approach the fault line they appear to be hurled backward from it and dip towards it at a steep angle of some 50°, the limestones and quartzites standing off shining in the sun like metal plates. It seems probable that the fault fissure between the sedimentaries and the granite may be here filled with a body of quartz as such appears at the top of the hill, though it is possible that this, as at the knob on Pennsylvania Hill may be only a highly metamorphosed quartzite instead of a true vein filling of a fissure. Whether or not the fissure itself is mineralized remains to be proven by later development.

In the mine the ore bodies lie in what appear to be fissures in a porphyry sheet, in some places they are ordinary contacts between limestone, shale or quartzite and porphyry. Wherever the strata have been pierced, or along the walls of the veins, evidences of intense slipping or shearing movements are apparent; the walls are polished by this movement, and pieces of black shale shine like plates of steel. The movement appears to have been like that of violently folding up a roll of paper or the sheets of an unbound book, the several sheets slipping upon and polishing one another and producing slipping fissures between them. Such

COAL FIELDS OF THE PHILIPPINES.

Facts in Regard to Their Location, Extent, Quality of the Coal, and the Opportunities for Profitable Operation.

By Mr. G. D. Rice*.

Since the practical conclusion of hostilities in the Philippine Islands there has been a great deal of prospecting done by representatives of American mining companies, individual miners, discharged soldiers of the army, and even the natives, with the result that all sorts of mineral deposits, including coal of a good quality, have been located and in some instances worked successfully. Your correspondent has recently returned from a trip to Cebu, Negros and Bataan. The finest beds of coal thus far developed are in the island of Bataan, where they extend over a large territory. Since the establishment of the mining bureau at Manila, by which mining papers are cleared and titles to lands sought out and adjusted, there has been a great movement towards the establishment of plants for the operating of the coal mines in the southern section of the Philippines. There are capitalists represented in the enterprises who control large and successful mines in the United States and other countries, and the indications are that within the year there will be important steps made in the working of the mines of the Philippines. In most cases the coal mines have been discovered by the miners who were prospecting for gold, silver, lead, copper or other valuable deposits, which are known to exist in Luzon, Panay, Negros, Mindanao, Gimeras, Bataan and Cebu. On Gimeras there are several mines in operation, but the coal mine there has not been developed to any important extent. On Panay, the coal mines are still in their infancy, and such specimens of coal as have been brought to notice are not

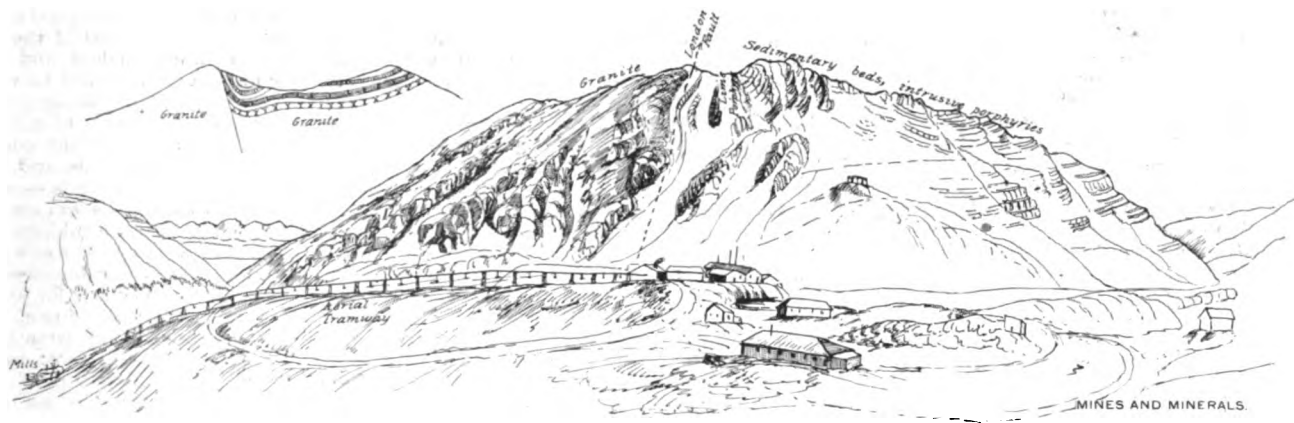


FIG. 4.—THE LONDON MINE.

fissures in the porphyry sheets have been filled with quartz veins carrying gold and silver-bearing ores. These veins are from a few inches to two or three feet wide, the ore consists of pyrite with some zinc and galena all containing more or less gold. The ore occurs in chutes at intervals with more or less valueless ground between. There are two veins which after a time merge or come together into one vein.

From want of accurate knowledge of the geology of the hill, it was supposed that these slip fissures might continue down into the granite below and a long cross-cut tunnel was contemplated to cut them at great depth down in the granite. We do not think these slips so continue but rather that they are confined to the sedimentary zone and its included porphyry sheets and that they conform to the bedding planes of the strata. The only thing that would be encountered by a cross-cut in the granite would be the fissures of the Great London Fault and whether or not this is mineralized is a matter at present for conjecture only.

Exploration for fresh veins or ore bodies or ore-bearing strata must be confined to cross-cuts and winzes in the sedimentary zone alone and particularly at contact with intrusive sheets of porphyry.

Effect of Locating Across the Vein.—Where by mistake a mining claim is located across, instead of along, the vein passing through the location point, the rights of the locator are governed by the facts as they exist with regard to such vein. His side lines, as located, become end lines, and he is not entitled to any extralateral rights thereunder, although another vein, extending transversely to the one intended to be located, may have apex inside of such surface lines.—*Cosmopolitan Min. Co. v. Foote et al.*, 101 Fed. Rep. (U. S.) 518.

of so good a grade as found in the beds of Bataan, Cebu and Negros. Mindanao is an extensive field for the operations of miners, and about the first thing that a new party of miners do when they arrive in the Philippines is to strike out for this island. The miners who have gone to Mindanao usually discover some sort of a mine, for there have been already established there mines for getting coal, iron, gold, silver, lead, copper and other metals.

Coal Mines are Extensive.—According to information secured from the mining bureau, from a number of miners who have prospected for coal, and from personal observation, the coal mines of the Philippines are practically the most extensive of any mineral. The geographical formation of the islands renders it difficult to locate the leads and follow them, but in cases where the prospectors have been successful, the results have proven very encouraging. In nearly all of the places which I visited it seems as if serious eruptions of the earth must have occurred some time in the past, and the results of these eruptions handicap mining. The volcanic eruptions of centuries ago evidently broke and separated the leads of coal, and the result is that, although the leads often extend over large territory, they frequently break abruptly, and one would suppose that that was the end of the lead. But if he follows the earth a short distance, he will locate the lead again. The eruptions seemed to have broken the leads all through the islands, with a resulting series of short leads.

Tracing the Leads.—But the miners have no trouble in tracing the general direction of these extensive leads. I have been with working parties who have followed the leads from one side of an island to the other without losing the general trend. When a lead stops, the other end, separated by volcanic eruptions, is

* From the American Gas Light Journal.

usually located shortly after. It would seem as if two great belts of coal extended through the archipelago at an angle of about 60° southwest and northeast. The interested parties are buying up considerable of the property in the vicinity of these belts with a view of working the same. The operations, however, are chiefly confined to the islands of Bataan, Cebu and Negros. Hardly anything has as yet been done in Luzon, Panay or other islands, beyond the preliminary preparations. The largest deposits of coal are evidently in the islands of Cebu and Negros, while Bataan has the reputation of having not only extensive beds but a fine grade of coal. From specimens furnished and subjected to the usual tests, the coal is of Tertiary age and a highly carbonized lignite.

Mines Worked Since 1827.—Mining is no new idea in the Philippines. The natives have been getting out coal and using it since 1827. The mining has been done on a small scale, and no works of any sort have been established, because the ladrones and freebooters of the mountains would have destroyed or looted any equipment put up. The mining of coal in the past, like all other mining in the Philippines, has been conducted with the crudest types of instruments, often the miners being supplied only with bamboo bars and wood scoops for shovels. At one place inspected by the writer, where even now they are working a native mine as of old, they did not have a single metal tool. Most of the work seemed to be done by hand. I saw natives use their hands to scoop up earth. They had little hammers made by entwining sharp pointed stones to the end of a stick, and these hammers served as picks and to break off pieces of the coal. This coal has been sold to water craft plying with mails and freight between the islands. It seems that the first coal mines were worked on the island of Cebu, and it is only recently that the better grades of coal on the islands of Bataan have been used. For many years the operations at the coal mines have been very irregular. Sometimes the mines would be operated full blast for a year and then remain idle for a same period. The natives are not inclined to work at mining or at any other operation, unless compelled to for need of money and food. It is only when driven to it that they will get out their tools and go to work. Therefore the best of mines have frequently been shut down for stated periods from this one cause, and, as is well known, it is very unsatisfactory to operate any kind of mines on this plan. I recollect in one instance where they stopped work, the mines flooded and considerable expense was entailed in getting the mine back into a paying order.

The Mine of Uling-Uling.—One of the chief mines of the Philippines is known commercially as "Uling-Uling," and it is located on the island of Cebu. The coal from this mine is said to be better in quality than either the Australian or the Shanghai coals, which are landed here for sale to the steamers and to the manufacturers of the islands who use steam power. The cost of the local coal, as compared to the cost of the imported, is, of course, much lower; yet the bad management of the mine mentioned above, such as shutting down for a period when the coal is most wanted, compels the users of coal to depend upon the dealers who handle the foreign coals, for the reason that the latter coals may always be found in stock and ready for delivery.

Future Prospects of Philippine Mines.—It is very evident that if the Americans had never taken possession of the islands the coal mines would be useless to the country. The few thousands of tons of coals taken from the mines each year were hardly sufficient in importance to cut any figure in the commercial transactions of the islands. There are a great many manufacturing industries distributed over the islands, all of which have been compelled to use wood, cane and other materials under the boilers of the steam plants because of inability to secure coal. These industries include mainly the sugar mills, of which there are dozens in every square mile, all using a boiler to operate the cane crushing machines and to raise the necessary steam for heating liquids, etc. In crossing the islands with a military expedition recently it seemed to me that we met with one of these isolated sugar mills at the rate of two and three in every mile on a straight line. There are a great many woodworking plants springing up under American control, and the owners inform me that, although wood fuel is available, they would prefer coal, if the latter can be obtained at proper prices and without trouble. Then there is considerable shipping touching at all of the principal points in the islands, all of which calls for coal for fuel purposes, and as the local mines have thus far been unable to keep the coal yards filled with coal, such coal as there is on hand is imported, and imported coal is very costly. It is sold in sacks, and the sacks are handled as if they contained precious metals.

There are railroads coming into existence in the islands, and the locomotives have to be changed over for burning wood because of lack of proper supplies of coal. It is just the same in the metal working industries. The steam plants were previously intended

to burn coal, but the latter not being obtainable, except at intervals, the proprietors find it best to have the furnaces changed for using wood. There is plenty of wood in the islands, but it is not of course satisfactory for service in all cases of steam raising.

For Gas Works.—There is no doubt if coal could be mined in proper quantities gas works would be established in the islands, for the reason that the expense of oils for illuminating purposes in the Philippines is exceedingly high. Oils for lamps are six times greater in cost than in America. By the time that the oils get transported to the interior, the cost per gallon is so high that only the rich can afford to have a light. I have seen whole barrios of people go to sleep shortly after dark because of not being able to afford a light. Now if it were possible to secure a sufficient supply of coal, there is little doubt that some of the enterprising Americans, who are here at the present time for the special purpose of introducing up-to-date ideas, would undertake to establish gas works. A gas works would pay handsome profits under the circumstances. The coal consumption would be considerable and the mining business assisted.

Coal Tar in Demand.—This is a great country for using vast quantities of coal tar. If gas works were established the consumption of tar in the islands is so great that the proprietors of the gas works would find themselves making considerable money from the sale of the coal tar. The reason for the call for coal tar is that much of the house building in the Philippines is done by means of split bamboo, and the tar is used to fill in the crevices. Then the shipping is usually built up by means of plaited work in split bamboo, the keel and lower portion of the native craft being solid wood, cut from a tree, while the sides are of this bamboo plaited work, in which the meshes are liberally filled with tar. The coal tar is at present shipped from England, Japan and Russia, and by the time it gets here it is costly. There are practically no paints available, so that the tar is often used as a paint on nipa huts and bamboo houses, for the reason that it makes a good coating and the tar keeps the vermin away. But the cost of the tar prevents its general use. If gas works were established, and the coal tar sold at reasonable rates, the market for it would be very large.

As to Roads.—Of course one of the leading features of mining in the Philippines is the condition of the roads. Your correspondent has been on the go for a year in these islands, and has traversed the roads of nearly all of the southern islands several times over, and found them to be uniformly bad in the wet season and only passable in the dry season. The American soldiers are doing wonders with the roads, however, as wherever the soldiers have established garrisons, they have made it their business to turn out the natives and compel them to grade the roads for miles in all directions. Then the bridges are nearly all down, the insurgents having burned many of them, but by the time this letter reaches the United States, the bridges will in most cases have been replaced; for the department commanders throughout the Philippines have ordered that district commanders see to it that all bridges within their district are rebuilt and the roads made passable for both the wet and dry seasons. The natives are called upon for this work, and hundreds of them are working at each of the crossings rebuilding the bridges. Transportation of the coal to the sea coast or to the markets of the interior can, therefore, be accomplished with practically little more difficulty than under ordinary circumstances in any country. In some of the mines now in operation they are getting the coal to the markets on pack animals, and these animals carry quite a load. In some places they use the caribou and the drag sled. This is the best way whenever the trails through the hills are wide enough for passage. If the trails are narrow, then only pack animals can be used, but even this mode does not overcome the narrow paths around some of the mountains. On one occasion I saw a pack horse go over the sides because the bag of coal on the inner side struck the wall of the mountain to the side of the path, causing the horse to lose his balance and go over the side.

Labor.—The cost of labor in this country is so exceedingly small that many of the defects of transportation and machinery are overcome.

The native laborers can be hired for 10 cents per day to work in the mines, and the only sort of shelter they need is a bamboo shack. They will expect to be provided with rice and tuba, costing about 3 cents per day for each man. Coolies can be secured at even a lower rate per day, one new mining company paying only 8 cents per day, and furnishing lodging and food for its laborers. There are plenty of men to work at this price, for the wars are practically over and the soldiery must go to work at something. Then there are the caribou and the native horses to use for purposes of transporting the products of the mine to the coast. These may be purchased outright for about \$6 gold each, or can be hired at the rate of about 10 cents per day each. The hours of working are from 6 A. M. to noon, when a two hours' rest is taken, and work is then resumed to 6 P. M.

Titles.—Many miners who have undertaken to develop coal and other mines in the Philippines have made the serious mistake of investing their capital in claims not properly adjusted. A year ago it was the custom for prospectors to settle down on any piece of mining property and hold it by force. They often had to shoot interfering natives, and trouble resulted sometimes in the natives forming, and as a result of the uprising, unless United States troops were near, the miners have been killed. I recollect of several parties attacked in this way. The best method is to first locate the property, and when it is assured that it is worth the working, a visit should be made to the Mining Bureau at Manila, which is controlled and officered by the Government, where the whole history of the property, as recorded by old Spanish land grants, may be secured. All papers relating to lands of all kinds are on record at this office, and when this office assures a miner that such and such a property is free for him to operate upon, or can be purchased from original owners at a stated price, then the miners can return to the lands, establish their rights and no one can interfere. But this habit of settling upon a piece of property, even when the native owner lives within sight in his shack, is a risky piece of business. The natives know no value in their land until they see Americans settle upon it, and begin to take out marketable products. Then they want to drive the prospectors off and work the mines themselves. Bloodshed invariably results, for the reason that, even if the native sells for a small sum of money, some other relative of the native or another claimant of the property will appear. But if the proper papers are secured from the bureau at Manila, the responsibility of ownership rests there, and the miner can refer the native to that office.

THE FIRST-AID PACKET

In Civil Practice and the Organization of First-Aid Societies. Their Value in Mining Regions.

By M. J. Shields, M. D., Jermyn, Pa., Attending Surgeon to the Carbondale Emergency Hospital.*

My object in writing this article is to call the attention of the profession, especially those physicians residing in mining regions and those who practice in manufacturing and railroad centres, to the value of the first-aid packet and also to the good that can be accomplished by the organization of first-aid societies in districts where their clientele are engaged in such hazardous occupations as mining, railroading, and iron working.

The idea is not original with me, for such societies have existed in England for a number of years under the name of the St. John Ambulance Association, which has for its president no less a personage than His Royal Highness the Prince of Wales, and among its other officers eminent men in all walks of life.

I have practiced during the whole of my professional career in the coal-mining regions of northeastern Pennsylvania, where we have a great many men who come from the mining districts of Great Britain, and in conversations with them the subject was first brought to my attention. We all know what serious results oftentimes follow mining accidents in the form of sepsis, loss of blood, tardy recovery, and sometimes permanent disability, all resulting from the filthy condition in which the surgeon finds the wounds and injuries and the time that elapses from the occurrence of the accident until the doctor gets to his patient, for these accidents (in mining) occur sometimes a great distance underground and sometimes several miles from the sufferer's home or the district hospital.

Then, also, the poor sufferer fares quite badly in the hands of his fellow-workmen, who all get excited in trying to aid, and oftentimes do the injured man more harm than good. Several instances have come to my knowledge in which miners who were trying to extricate an injured man from under a fall of coal have lost their heads and either walked or stood on top of the pile of coal that was pinning the poor fellow down, thereby adding several hundred pounds to the weight that was on top of him, and when he was finally got out he was handled sometimes roughly, owing to the excitement or lack of training of his brother-workmen. So, knowing all these things and believing that if an organization on the same plan as that of the St. John Ambulance Association could be started, I was sure it would be the means of doing much good to suffering humanity and would be of great benefit to the surgeon who attended these cases by securing cleanliness of the wounds, less shock from loss of blood, etc.

Accordingly, about February 1, 1900, I organized a society consisting of twenty-five men, all working in one colliery. This colliery employs about 400 men and has five headings, or main

gangways. These twenty-five men are divided into squads of five, and one squad is distributed along each gangway of the mine. One of the five is chief of the squad and is selected after passing an examination on the topics pertaining to the first aid to the injured. In his keeping is a small box containing cotton, a rubber tourniquet, flexible splints, a bottle of olive oil and lime water, a bottle of aromatic spirit of ammonia, a small glass, and a spoon. There is also a folding stretcher kept in each gangway, and each member of the squad is provided with a first-aid packet, which he carries with him.

The society meets twice a month, and at each meeting some other physician or myself gives short talks on the subject of first aid. Each member has a little book called *First Aid to the Injured*, written by the late Dr. Peter Shepard, surgeon-major, British Army, which is published in London by the St. John Ambulance Association, and contains in its hundred pages about all that is needed for the average working man. I have them study this book, which contains some anatomy, a little physiology, some information about bandaging, and instructions as to how to care for injured persons till medical aid arrives. It also contains rules for resuscitating persons whose breathing has become feeble or ceased, in cases of hanging, drowning, poisoning from opium or gas, and electric shock. The book also gives a stretcher drill and full directions as to lifting and carrying an injured person. I could not find anything published in this country that suited my purpose, in point of brevity and cheapness, as this work does, which costs only thirty cents delivered in the United States. Of course, there are several excellent works written and published in this country; the one by Dr. Doty is an excellent one, but it is too extensive and the cost too much (\$1.50) for the average miner.

As regards the financial affairs of this society and the means of raising money for the purchase of material, first-aid packets, etc., in every mining and manufacturing district, as is well known, there are a number of accident and benefit societies which pay their members so much a week in case of accident, and they can be made to understand that such an organization is the means of getting its members who are injured back at work sooner than would otherwise be the case, which means a saving of money to the benevolent society or lodge.

Now, in my town, we have a number of such organizations, and they have all contributed to the first aid in both men and money, and the miners have as individuals contributed a small sum, I think ten cents each. As we are equipped now with forty-eight first-aid packets, tourniquets, splints, stretchers, and books, the total cost of which has only been \$50.00, we have not yet asked the mining companies for any financial assistance, but I have no doubt that if we needed it and the matter was put before them they would willingly contribute to such a cause.

As I stated in the beginning, my sole purpose in writing this article is to bring this matter before the physicians who are living in districts where men, from their occupation, are unusually liable to accidents; and, as we are or should be in this progressive age interested in preventive medicine and surgery, I think this matter is worthy of much consideration and I have not the least doubt that whoever once takes the initiative will have the zealous and hearty cooperation of his patrons and the public. In my case the men whom I have organized have entered the work with zeal and are faithful in trying to learn how to aid their fellow-workers, giving their time and money to aid their unfortunate collaborators.

In closing, I should like to state that the physician who organizes a first-aid society should carefully select his men; they should be of temperate habits; men who are intelligent and conscientious, men who will be faithful and punctual in attending the meetings of the society, and men who understand that they are doing this for sweet charity's sake, that do not get disconcerted easily, and have no aversion to the sight of blood. In our organization I had to weed out several who could not stand the sight of blood or of an injured person.

Physicians who have practiced any length of time in a community soon get to know who is capable of helping in accidents, and these are the men to be selected. Then, again, there is no need to provide every man who works in the rolling mill, factory, or mine with a first-aid packet, because the men usually work together and some one who belongs to the society is almost always present or not far away and can be almost instantly in attendance.

These classes or societies can follow a prescribed course for a year or so, and then a certain number of the most proficient should pass an examination and be given a certificate. Then new members could be brought in, and if there were several societies in the vicinity interest should be kept up by competitive stretcher drills, trials of skill in bandaging, etc. I should also recommend that the members of such societies wear a badge or boutonniere of some suitable design, so that they could be easily found in case of accident.

* New York Medical Journal, Sept. 8, 1900.

THE ELECTRIC MINE LOCOMOTIVE.

Its Development as Illustrated by a Comparison of One Built in 1889 With Those Now in Use.

A comparison of the modern electric locomotive with its prototype of a few years ago shows in a striking manner the rapid

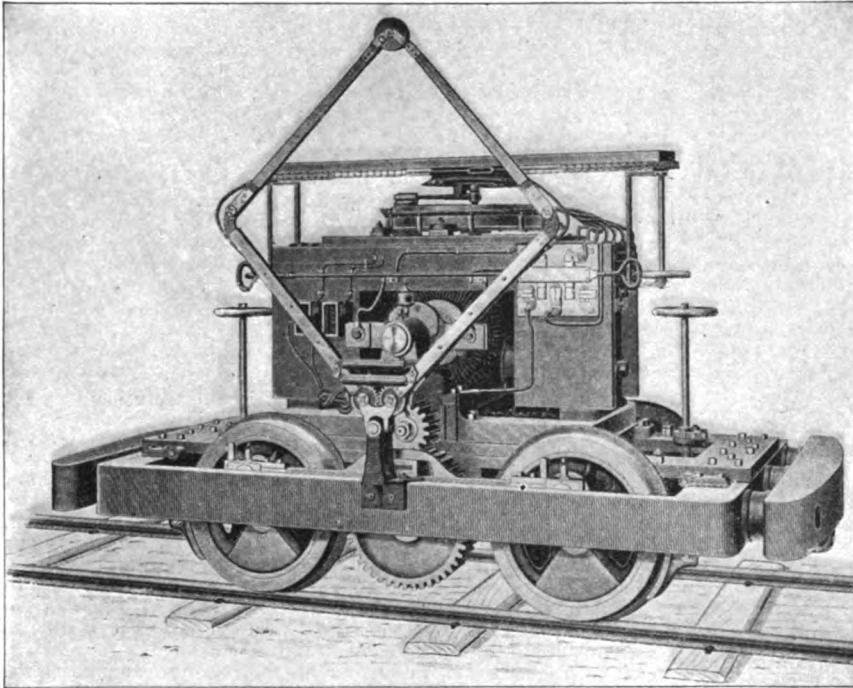


FIG. 1.—H. M. 80. MINE LOCOMOTIVE. INSTALLED IN 1889. STILL IN USE.

advance of modern engineering. The electric mine locomotive has long since passed the experimental stage, and, by years of successful service, has clearly demonstrated its superiority, under ordinary conditions, as compared with rope haulage and compressed air or steam mine locomotives. It must be admitted, however, that the various rope haulage systems possess important advantages on severe grades of any considerable length. One of the earliest types of the electric mine locomotive is shown in Fig. 1. This locomotive is a veritable pioneer and was built in 1889 by the Thomson-Houston Electric Company for the Erie Colliery of the Hillside Coal & Iron Company near Scranton, Pa. A locomotive known as the "Terrapin Back," was built by the same Company in 1891 and several of these machines have operated continuously up to the present time and doubtless still have a long future of usefulness.

The locomotive illustrated in Fig. 2 is the most modern type and is the result of a process of evolution, of continual change and improvement. The contrast between the locomotives shown in Figs. 1 and 2 is very striking and shows the marvelous development that has been made in the design of electric locomotives within a very few years. In the design of this locomotive the following important requirements have been constantly kept in view: 1. Reliability and convenience of operation. 2. Easy access to all parts for examination and renewal. 3. Ease and perfection of control. 4. Economy of current consumption. 5. Large momentary over-load capacity. 6. Immunity from injury due to derailment, fall of roof or other accidents common in mines.

It may be of interest to point out some of the salient features of modern mine locomotive practice. The motors form the most important part of the locomotive and should be thoroughly waterproof and of ample capacity. The locomotives manufactured by the General Electric Company are equipped with standard street railway motors which represent many years of

experience in the field of electric traction. The same remarks apply to the controller, which is of the well known magnetic blow-out type, to whose excellence is due, to a great extent, the remarkable development of the electric street railway. This type of controller may be found the world over and is a very important feature of a mine locomotive, which operates under the most severe conditions. The superiority of this controller is due to the magnetic blow-out which automatically extinguishes the arcs at the contact fingers, and without this feature it is doubtful if the mileage of the electric street railways in the United States alone would have, at the present time reached the marvelous aggregate of 20,000 miles.

The standard mine locomotive manufactured by the General Electric Company consists of two heavy side frames and two end frames of cast iron, accurately machined at the joints and held together by heavy bolts. The weight of the locomotive is supported by the axle boxes through heavy double coiled springs. The motors are mounted on the axles, which are driven through the medium of a gear and pinion with machine cut teeth running in a gear case partially filled with oil. As the motors are spring suspended from the side frames, the axles carry directly only a portion of their weight, and the jars and strains due to rough tracks, are reduced to a minimum. At one end of the locomotive is collected the operating apparatus including the controller, brake stand and sand levers. Special attention has been directed to the brake mechanism, covered by letters patent, by means of which the operator may skid the wheels on a dry track with a very slight muscular exertion. It is unnecessary to tug and strain at the brake wheel to effect a stop, and, due to the absence of all pawls and ratchets, the brake will remain indefinitely in any position in which it may be left by the operator.

The arrangement of the brake mechanism is such that the wear of the brake shoes is automatically "taken up," a feature of great importance.

One of the best evidences of the increasing importance of mining and of the great interest that is being taken in it by the general public is the fact that the mining schools and colleges throughout the country report large increases in the numbers enrolling. In a recent issue the Mining and Scientific Press says that the drift of young men toward mining engineering is illustrated in the number taking the mining course in the University of California at Berkeley which number has increased from 5 in 1892 to 190 in 1900. Probably an even better indication of

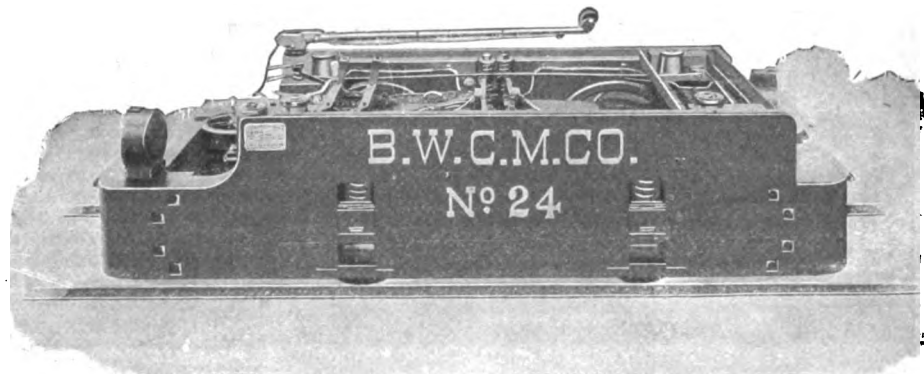


FIG. 2.—LATEST TYPE OF GENERAL ELECTRIC 13-TON ELECTRIC MINE LOCOMOTIVE. DRAWBAR PULL, 5,000 LBS. SPEED, 6 MILES PER HOUR.

this increasing interest is the fact that during the same period the number of students in the mining courses of The International Correspondence Schools, of Scranton, Pa., has increased from zero in 1892 when the Schools were first started to about 10,000 at the present time. As these Schools draw their patrons not from any one section, but from all over the United States, Canada, and Mexico and indeed from the whole world, this increase shows that there is a very wide and active interest being taken in mining education.

OBITUARY.

FRANK WILLIAMS.

Mr. Frank Williams, well known by all connected with the iron and steel industries of the country, died at his home, Johnstown, Pa., October 16th, 1900. Mr. Williams was born May 19, 1865, in Johnstown, where his father was superintendent of the Johnstown Water & Gas Co. for many years.

Mr. Williams received his elementary education in Johnstown, and after leaving the high school spent two years in the laboratory of the Cambria Iron Co., entering Lehigh University September, 1883. He there took a course in lurgy, graduating in 1887 with the degree of B. S., and after a year of post-graduate study received the degree of E. M. During his course, he played on the foot ball team and was a member of numerous college societies and organizations both social and scientific. His previous experience in the laboratory of Cambria Iron Co. enabled him to take every advantage of his college training. He was always known as a faithful, practical student and stood among the highest in his class, being a member of the Tau Beta Pi, the honor society for technical students at Lehigh University.

After leaving Lehigh, Mr. Williams accepted a position with the Edgar Thomson Steel Company, and later went to work for the Michigan Steel Company, at Detroit. When he left Detroit he went to Europe to study the basic method of making steel. Upon his return he remodeled the plant of the Horseshoe Company, in Chicago, and later had charge of the East Chicago foundry. While in this position his health began to fail and he was compelled to leave Chicago. After traveling two years, he took charge of the Fayette Manufacturing Company, at Layton, Pa., and several years later was chosen President and General Manager. He organized a brick company in Johnstown, and had charge of the plant here and the one at Layton until a short time ago, when he was compelled to resign his position on account of his health.

Mr. Williams was a member of the Duquesne and University Clubs of Pittsburgh. While a student at Lehigh, he joined the Protestant Episcopal Church of the Nativity. He had been very successful in business, and had accumulated a fortune, \$300,000 of which he left to Lehigh University as a perpetual fund from which loans can be made to students needing money to assist them in obtaining a college education. These loans are to be repaid by the recipients and are to be secured by personal notes of the beneficiaries.

Although Mr. Williams had been in failing health for many years and had been compelled to pass the winters in a milder climate, none of his many friends imagined that the end was so near, and the announcement of his death came as a great shock. He was in every way a manly man, a true friend, and one thoroughly respected by all who knew him or who had ever been associated with him in any way.

JAMES H. BOWDEN.

The many friends of J. H. Bowden, of Wilkes-Barre, Pa., were shocked to hear of his death, which occurred at Meadville, Pa., where he went about the middle of September, suffering with stomach trouble and placed himself under the treatment of Dr. Dewey, the specialist. The treatment progressed favorably, until Thursday, Nov. 15th, when he began to decline rapidly and died on Friday night at 7 o'clock. Mrs. Bowden was with him during his stay in Meadville and was at his bedside at the time of death.

Mr. Bowden was one of the best known mining engineers in the anthracite region and was noted for the originality and cleverness of his designs of mining machinery. He was born at Penzance, in Cornwall, England, in 1846, and came to this country when a small child with his parents. The latter settled in Tamaqua, Pa., where he was reared and received his elementary education. He was apprenticed to the machinist's trade at the shops of Carter & Allen at Tamaqua and completed his trade in Philadelphia, where he afterwards attended a technical school studying to become a mechanical engineer.

He settled in Wilkes-Barre in 1869 and was made superintendent of the Wyoming Valley shops. In 1872 he formed a partnership with Maj. Irving A. Stearns under the firm name of Stearns & Bowden as general engineers. In 1873 he accepted the position of chief engineer of the Susquehanna Coal Co. and later became the chief engineer of all the coal companies connected with the Pennsylvania R. R. Co. He has been borough engineer of Nanticoke from the time of its incorporation until recently. He was one of the first members of the American Institute of Mining Engineers, was a prominent member of the American Society of Mechanical Engineers, and had contributed to the Transactions of these societies at numerous times. One of his latest papers was a

description of the compressed air haulage plant at Glen Lyon which was read at the Canadian meeting of the Mining Engineers in August last. Mr. Bowden held several patents, the most prominent of which is the Bowden self-oiling car wheel, now extensively used in the anthracite region. He was a recognized engineer of great ability and was esteemed highly by the coal companies by whom he was employed. Mr. Bowden recently completed, to be published in the forthcoming history of the Pennsylvania R. R., an exhaustive record of the anthracite coal mining industry of Pennsylvania, as well as a history of all the coal companies now under the management of the Pennsylvania R. R. This work was finished only a short time since, and it is to be regretted he could not have seen its publication. It comprises a record of the anthracite industry from the time of the first shipments to the year 1900, that will prove a most valuable addition to the history of anthracite coal. Deceased was a sportsman of note and was a member of the local asso-

ciation. In private life he was genial and whole-souled and his death is sincerely regretted by a large circle of friends. Mr. Bowden was twice married, his first wife being Miss Juliet Metzgar, sister of Charles B. Metzgar, and the second Miss Eylla Flack. The latter with three children, Helen (Mrs. Fred A. Krell, of Tamaqua), Grace and Dorothy, survive. Mr. Bowden was an attendant at St. Stephen's Church. The funeral was held at his late residence, 49 Park avenue, Wilkes-Barre, on Tuesday, November 20, at 2 o'clock.

The Unwatering of the Comstock Lode.

In response to a letter asking for the present condition of the work of unwatering the Comstock Lode, the Risdon Iron and Locomotive Works, of San Francisco, Cal., which company has charge of this work of unwatering, has replied as follows: "The work of unwatering has been going on for the past year and a half, and we are now down some 420 feet below the Sutro Tunnel. The great difficulty is in getting at the discharge boxes to find out the quantity of water we are discharging. This is almost an impossibility, owing to the position of the discharge adit.

"The Evans elevators are working very satisfactorily indeed, and now that the 2,150 foot level is about unwatered, we propose to establish a permanent base, and to put in a permanent set of pumps at this point. We have been working on this for some time and owing to the lack of pressure water used for operating the Evans Elevators, it will be necessary to put in some other system for the permanent equipment. We intend to use electricity, the electricity being furnished by the Truckee River General Electric Co., the power station

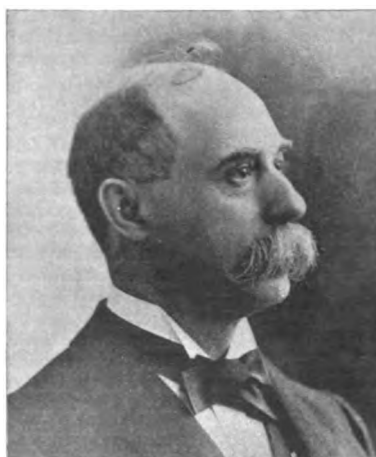
being on the Truckee River near Floriston, at a distance of some 20 to 25 miles from the Comstock Lode. This is now complete and the power will be in Virginia City by the 15th of October.

"The system of pumping proposed to be used is that known as the Joseph Moore system, which is fully described in our catalogue."

Catalogue No. 10 of the Risdon Iron & Locomotive Works contains a description and particulars of the pumps used at the Comstock, and will be found very interesting reading to those who have followed this great undertaking in the unwatering of mines. This company also issues a series of catalogues which describe their dredging and all other kinds of mining machinery.



FRANK WILLIAMS.



JAMES H. BOWDEN.

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PROMOTION AND ENCOURAGEMENT OF MINING SCIENCE IN THE UNITED STATES.

DURING the first session of the present Congress an act was passed in the Senate and a bill favorably considered by the Committee on Mines of the House of Representatives, intended to promote and encourage the mining and metallurgical sciences in the United States by appropriating yearly to each State and Territory a certain sum of money for the support and maintenance of a school of mines.

The following are the essential clauses of the bill now before the House of Representatives and which will come before the next session of Congress for action. The sections not here quoted apply merely to details of administration which are not of general interest.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided to each State and Territory for the establishment and maintenance of schools or departments of mines and mining in connection with the colleges for the benefit of agriculture and the mechanic arts, now established or which may be hereafter established in accordance with the provisions of an Act of Congress approved July 2, 1862, the sum of \$10,000 for the year ending June 30, 1901, and an annual increase of the amount of such appropriation thereafter for five years by an additional sum of \$1,000 over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be \$15,000."

SEC. 2. "That said appropriations shall be expended only for geological instruction, mining engineering, metallurgy, research in road-building material and its proper application, and the branches of learning pertaining thereto, including the various branches of physical, natural, and economic science and the facilities for such instruction, research, and experiment, in order to promote a liberal and practical education and secure the most intelligent use, conservation, and development of the mineral resources of the country.

SEC. 3. That the benefits of this Act shall apply to the several organized Territories within the United States, and the appropriations hereby made shall be paid, in the manner and on the conditions herein specified, to the colleges for the benefit of agriculture and the mechanic arts now established or hereafter to be established by the legislatures of said Territories, respectively. In any State or Territory where a school of mines has been established by the legislature thereof, separate from the colleges or universities hereinbefore named, the appropriation hereby made shall be paid in the manner hereinafter specified to the duly authorized treasurer of such school of mines.

SEC. 6. "No portion of said moneys shall be applied directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings: *Provided, however, That a sum not exceeding twenty per centum of any annual appropriation received by any institution may be used in the construction, erection, equipment, or building of special apparatus and machines or plants necessary to carry out the purposes of this Act.*"

SEC. 7. "That a detailed report of all operations conducted by the respective schools or departments of mines, during each year ending the thirtieth day of June, shall be transmitted on or before the first day of the following November to the governor of the State or Territory in which said college or school is established, and a printed copy of said report shall be sent to each school or department of mines herein provided for, and to the Secretary of the Interior. Said report shall contain a statement of all experiments and work of a practical and scientific nature conducted during the preceding year, which may be considered of special value to the mining and metallurgical industries, together with the condition and progress of such school or department, including general information as to the number of its professors and students, its courses and methods of instruction, its library and general equipment. Bulletins or supplementary reports shall be published by said schools or departments from time to time on subjects of importance to the mining community or to the interests of any particular branch of mining industry or mining districts. Such bulletins or reports and the annual reports of the several schools or departments of mines, whether printed separately or as parts of the reports of the institutions with which said schools or departments are severally connected, shall be transmitted in the mails of the United States free of charge for postage under such regulations as the Postmaster-General may from time to time prescribe."

No argument should be required to justify the enactment of such legislation. The mining interests of the country deserve the highest consideration from the Government, which is not here asked to try an educational experiment. By the Acts of 1862, 1887 and 1890, the Government has generously provided for the establishment and maintenance of institutions for the teaching of agriculture and the mechanic arts, and for experiment stations where scientific investigation along agricultural lines can be systematically carried out. These institutions have now been on

trial for nearly 40 years, and the results which they have accomplished are well known, their reputation is world wide, and so much benefit has come to workers in agriculture and in mechanic arts, that there should be no hesitancy or delay in making similar provision for the mining and metallurgical industries.

A number of the Land Grant Institutions have undertaken to maintain mining departments, but the increased demands along the lines for which these institutions were primarily established have, in nearly all cases, necessarily crowded mining instruction into the background, and even where it has been possible to provide instruction in the branches of knowledge relating to mining, it has not been possible to provide the apparatus and equipment necessary for research and experiment.

The era of scientific experimentation and research along mining and metallurgical lines is only just beginning, and the field for development is almost limitless. The laboratory is no longer looked upon simply as a necessary evil about a mine or furnace, but it is rapidly taking its proper place and is now considered an essential and useful adjunct of an up to date plant. This means a higher grade of management and superintendency, and the aspirant for mining honors in the future must recognize that mining and metallurgical engineering are every year being placed upon a higher plane. It is therefore absolutely necessary that there be proper facilities available for those who wish to fit themselves for this higher grade of work.

The enormous increase in our mineral production within comparatively few years has not been due to the discovery of Eldorados, but it has been brought about very largely through the development of methods and processes for treating cheaply large quantities of low grade material, which, only a few years ago, would have been considered worthless and would have been thrown upon the dump. These processes are the direct outcome of laboratory experimentation, and no better example of this can be found than in the rapid development of the cyanide process for the extraction of gold. Without this process South Africa would not now be the world's greatest gold producer, nor would Cripple Creek be the world's greatest gold mining camp.

The amount of the appropriation asked for the first year, \$480,000, is very small compared with the mineral production of the United States for 1899, which was about \$1,000,000,000. An investment of less than one-half of one per cent. of its income would be considered a very meager outlay by any business man along lines that must almost certainly increase the earning power of his business within a very short time. By the appropriation of this money to institutions which are already established, a large amount of the preliminary work will be avoided and the magnificent chemical and mechanical plants which have already been provided at many of the Land Grant Institutions will immediately become available in connection with the proposed courses in mining, so that the beneficial results of such legislation must become apparent in the very near future. As has been noted above, courses of instruction have already been mapped out in many of these institutions, and work along these lines can be pushed as soon as funds are available for properly prosecuting such work.

The funds from which these appropriations are to be taken come from the sale of the public lands, and such use of these funds is in direct line with similar Congressional legislation for educational purposes during the last 40 years.

THE WOLF MEMORIAL FOUNTAIN.

IT IS very gratifying in these days of strikes and controversies between capital and labor, between employer and employed, to report an action having directly the opposite import. The readers of MINES AND MINERALS will recall an obituary notice which appeared several months ago of Mr. John F. Wolf, formerly Superintendent of the Penn Gas Coal Co., Irwin, Pa. A fountain is being erected as a memorial to him in the town of Irwin, which will be known as the "Wolf Memorial Drinking Fountain." This

fountain is 15½ feet high, and is to be surmounted by a life sized statue of Mr. Wolf. The money for the fountain has been raised largely by the miners who were formerly under Mr. Wolf's superintendency, though the business men of Irwin have also contributed. The Council of the city has given the ground needed and will maintain the fountain, while the Irwin Water Company will furnish water to it perpetually. This fountain will be a continued and effectual object lesson illustrating what the relation may be between employer and employe, even at the beginning of the 20th century, pessimists to the contrary notwithstanding.

STANDARD MINE MACHINERY.

THE advantage of standardizing as much of the machinery and as many of the appliances about a mine as possible, is admitted by all, yet when it comes to actual equipment of a plant this principle is often lost sight of almost entirely.

In certain districts each individual mine is a law unto itself and instead of finding uniform or standard appliances at mines operating under very similar conditions, there are as many varieties and types as there are mines. This is by no means a universal rule, and it is encouraging to note that it is a practice that is being steadily changed for the better. The grouping of a large number of mines under one management should and usually does mean the standardizing of every thing possible connected with these mines, thus reducing not only the original cost, but the repair bill as well. Whatever objection may be raised to such combination, this advantage must be admitted by all, as it does not reduce the earnings of the laboring class, and should reduce the price of the marketed product.

One of the best examples of possible improvements and economies in this direction is in the matter of mine cars. In opening up a mine and in laying the track the gauge can usually be selected with respect to the gauge of some standard mine car which is already on the market. It is the height of folly to first lay the track and then have special cars built to suit this gauge, differing possibly from the standard gauge by only a fraction of an inch, and thus greatly increasing the cost of equipment and repairs without in any way increasing the efficiency of the hauling system. Foolish as such a procedure is, how often is it practiced.

When a mine is first being opened up, in the rush to get out some salable product a definite plan of future development is frequently lost sight of, and the old adage that "the more haste the less speed" is being constantly verified in mining practice.

The article by Mr. J. Fox Tallis upon "Welsh Mine Cars," on page 198 of the present issue of MINES AND MINERALS is a plea for some such standardizing in connection with mining operations in the coal mines of Southern Wales. It is doubtful if there is any district in America of equal extent which shows the same amount of variation in the design of its mine cars as is shown by the several different types which we have illustrated, and still more strikingly by the twenty-eight different cars whose dimensions Mr. Tallis has tabulated. An examination of this table suggests a studied departure from anything like a standard, but if we understand correctly the difference between American and British engineering practice, these designs of mine cars are strictly in line with the common British machine design practice.

Although there may not be the same lack of uniformity in our own designs as there is in the illustrations given by Mr. Tallis, we have diversity enough, and there is abundant room for improvement in this line. His suggestions can well be taken to heart and some of his criticisms apply equally to American and British practice. The suggestions in regard to ball bearing wheels and fixed couplings are well worthy of attention, and while the time has probably not yet come for using metal ties in our mines to any extent, there are certain sections of the country where the timber cost is a most formidable item of expense in connection with mining, and anything that will reduce this item of expense is a desideratum.

Mr. Tallis seems to agree with American practice in the material for constructing the bodies of mine cars, as he prefers timber to metal, since the former is much more easily removed in case of a wreck and the cars more easily repaired in case of accident. This objection applies mainly to cars which are run in trips for hauling material over long distances and not to the smaller iron and steel cars which are such great favorites in many metal mines where the cars are mainly pushed by hand for short distances and where they are not run in trips.

A similar comparison of mine cars from American districts would prove most interesting.

TEXAS GEOLOGICAL SURVEY.

DOCTOR WILLIAM B. PHILLIPS has given up his office in Pittsburg to take up work in connection with the Texas State University at Austin, Texas, where he has been appointed to take charge of the field and economic geology work of the University. In this connection he will have charge of the organization and management of a geological survey of the State under the auspices of the University.

The geological work of the State of Texas was very well begun several years ago under Professor Dumble, and it is regretted that the work has been allowed to lapse so long, but the State is fortunate in securing the services of so well equipped and thoroughly scientific a man as Doctor Phillips, who has had a thorough University training, both in America and in Germany, coupled with extensive and varied field experience in geology, mining, and metallurgy. For a number of years Doctor Phillips had a chemical laboratory in Birmingham, Ala., where he was associated with Mr. C. R. Claghorn, at present a well known coal operator of Central Pennsylvania. Since giving up his laboratory, he has devoted himself mainly to expert and experimental work, having carried on elaborate experiments upon the magnetic concentration of the Southern iron ores, while his expert examinations have been made in nearly all sections of the United States, though he has worked mainly in the south, middle, and southwestern sections of the country.

Doctor Phillips has been a frequent contributor to technical literature and is one of the translators of the Wedding's "Basic Bessemer Steel." Judging from the character of his reports which we have seen in the past, and from his other writings, we feel safe in predicting that his geological reports will be of great value to the State of Texas, as they will undoubtedly be reliable and conservative and the boom element will be entirely absent.

The State of Texas is to be congratulated upon its good fortune in securing so competent and well known a geologist and engineer.

BOOK REVIEW.

STATUTORY RULE AND ORDERS FOR THE COAL MINES OF GREAT BRITAIN. Pamphlet 30 pages.

THE LARAMIE CEMENT PLASTER, by E. E. Slosson and R. B. Moudy, Laramie, Wyo. 17 pages.

THE NEW YORK STATE COLLEGE OF FORESTRY ANNOUNCEMENT OF 1900-1901, Ithaca, New York. Cornell University. 35 pages.

THE STATISTICAL YEAR-BOOK OF CANADA FOR 1899, issued by the Department of Agriculture, Ottawa. Price 50 cents. 625 pages.

TRANSACTIONS OF THE NEW SOUTH WALES CHAMBER OF MINES, September 1900, R. J. Etheridge, Secretary, Sydney, New South Wales.

OHIO STATE UNIVERSITY. Thirtieth Annual Report for the year ending June 30, 1900. This is a detailed statement of the faculty, students and courses of the University.

POCKET COMPANION CONTAINING USEFUL INFORMATION AND TABLES APPERTAINING TO THE USE OF STEEL, as Manufactured by the Carnegie Steel Company, Pittsburg, Pa. Price \$2.00. 319 pages. This edition of 1900 does not differ materially from that of 1896, the same general arrangement and style being followed.

UNITED STATES GEOLOGICAL SURVEY BULLETINS, Washington, D. C. "The Production of Antimony in 1899," 8 pages; "The Production of Fluorspar in 1899," 4 pages; "The Production of Mica in 1899," 6 pages; "The Production of Phosphate Rock in 1899," 26 pages, by E. W. Parker. "The Production of Iron Ores in 1899," 41 pages, by John Birkinbine.

ANALYSES OF PIG IRON, Collected and Published by Seymour R. Church, San Francisco, Cal. Price \$2.50, post-paid to any part of the United States or Canada. 173 pages. A collection of iron ore analyses with a few photographs of blast furnaces and a number of full sized illustrations showing very nicely the grain and appearance of certain typical brands of pig iron.

BULLETIN DE LA SOCIÉTÉ DE L'INDUSTRIE MINÉRALE. Volume 14, 3 parts, 3 series. 479 pages, published by J. Thomas & Co., Saint-Etienne. First Part. A report prepared for the International Congress of Mining and Metallurgy held in connection with the Paris Exposition. This report is divided into two sections. 1st, the Employment of Explosives in Mines. 2nd, Condition of Exploitation at Great Depths.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION, UNITED STATES NATIONAL MUSEUM, WASHINGTON, D. C., Chas. D. Walcott, Acting Assistant Secretary, in charge of the United States National Museum. 1,270 pages. Part I contains the report of the organization of the National Museum. Part II, which includes all but 153 pages, has a scientific discussion of the Crocodilians, Lizards, and Snakes of North America, by Edward Drinker Cope.

FAMOUS GOLD NUGGETS OF THE WORLD, by Thomas Jefferson Hurley, No. 33 Wall Street, New York City. 64 pages.

This pamphlet contains some interesting facts about some of the world's nuggets, but its name is far too comprehensive, as it treats of only a few of those that have been found in America. Typographically it is poorly gotten up and the arrangement of the book is not of the best.

PROGRAM OF EXCURSIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS UNDER THE AUSPICES OF THE CANADIAN MINING INSTITUTE AND MINING SOCIETY OF NOVA SCOTIA. This very interesting souvenir was presented to the American mining engineers who visited Canada during the last summer. It contains a large number of very interesting photographs of Canadian mining matters and a description of the plants illustrated in the photographs.

AMERICAN INSTITUTE OF MINING ENGINEERS, 99 John St., New York City, the following papers have been received: Lindgren, Metasomatic Processes in Fissure Veins; Carpenter, Pyritic Smelting in the Black Hills; Herzig, A Method for Obtaining the Volume of Small Drifts and Working-Places, Where it is Impossible to Use a Transit; Rickard, The Telluride-Ores of Cripple Creek and Kalgoorlie; Wilkinson, A Mining Survey; Page, The Explosion at the Red-Ash Colliery, Fayette County, West Virginia; Hamilton & Withrow, The Progress of Mineralogy in 1899.—Bulletin No. II: Discussion, Coal Outcrops; Discussion, A New Method for Working Deep Coal-Beds; Postscript, The Oil-Bearing Shales of the Coast of Brazil. List of Members

ILLUSTRATED CATALOGUE OF NARROW GAUGE LOCOMOTIVES. Adapted Especially to Gauges of 3 feet 6 inches. 452 pages. Baldwin Locomotive Works, Philadelphia, Pa. Although nominally a catalogue, this volume is much more than the ordinary name catalogue implies. The first 89 pages are devoted to a history of the Baldwin Locomotive Works, which means a history of the locomotive construction in the United States, and which contains a large amount of very interesting historical matter. This is followed by a number of pages of data upon the hauling capacity of the locomotive, general specifications, and physical tests of the materials of construction. Then come detailed descriptions of a large number of narrow gauge locomotives, all very thoroughly indexed. The work is a most excellent example of typography, and is another of the textbook book catalogues which have now become a necessary part of every scientific library.

DEPARTMENT OF MINES AND AGRICULTURE, Sydney, New South Wales. Annual Report of the Department of Mines and Agriculture of New South Wales for the year 1898, 203 pages, contains the following papers: Diamonds: Their Occurrence in New South Wales, by D. C. McLachlan, for 1899, 18 pages. Report on the Hillgrove Gold-Field, by E. C. Andrews, B. A. Mercury, or "Quicksilver," in New South Wales, with Notes on its Occurrence in other Colonies and Countries, by J. E. Carne, F. G. S., 36 pages. The Copper-Mining Industry and the Distribution of Copper Ores in New South Wales, by J. E. Carne, F. G. S., 197 pages. Report on the Wyalong Gold-Fields, by J. A. Watt, M. A., B. Sc., 40 pages. Notes on the Occurrence of Bismuth Ores in New South Wales, by J. A. Watt, M. A., B. Sc., 11 pages. Notes on Gold Dredging with Reference to the Introduction of the Industry into New South Wales, by J. B. Jaquet, A. R. S. M., F. G. S., 21 pages. Notes on the Occurrence of Tungsten Ores in New South Wales, with a Register of Localities, by J. E. Carne, F. G. S., 9 pages.

MANUAL OF EXPLOSIVES. A Brief Guide for the Use of Miners and Quarrymen, by Courtney DeKalb, Professor of Mining, Kingston School of Mines. Issued by the Ontario Bureau of Mines, Ontario. 126 pages. This is an excellent little book which has been prepared by Professor DeKalb for the Ontario Bureau of Mines for the benefit of the Mine Managers, Foremen and all others in the Province having charge of explosive materials. The author says in his letter of transmittal that it is partly a compilation from the literature upon explosives, partly the result of direct inquiries from recognized authorities, and is also based upon his own experience in the use and testing of explosives. He does not claim it to be an exhaustive treatment of the subject in any way and frequently refers the reader to the more complete works on the subject. It will undoubtedly prove a most valuable assistant to the mining men of Ontario, and great credit is due the Ontario Bureau of Mines in issuing so useful a manual.

THE METALLURGY OF GOLD, by M. Eissler, Fifth Edition, Enlarged and Rearranged. Crosby Lockwood and D. Van Nostrand Company, New York City. 625 pages. Price \$7.50. That a fifth addition of this work within twelve years after its first appearance should be required is a most favorable commentary upon the favor with which the previous editions have been received. The book is too well known to need description, excepting the changes that have been made in the present edition, where a large number of new diagrams, halftones and other very excellent illustrations have been introduced. The book has been enlarged and its appearance generally improved. A complete rearrangement of the text has been made with advantage and this is a decided improvement, as some of the earlier issues were open to criticism of poor arrangement.

Part I is introductory and treats of the general properties of gold and of hydraulic mining and metallurgy. Part II, the Mining of Gold. Part III, Treatment of Gold Bearing Ores. Part IV, Hydraulic Metallurgy of Gold Ore. Part V, The Cyanide Process. Part VI, Testing and Refining of Gold.

PROGRESS OF INVENTION IN THE NINETEENTH CENTURY, by Edward W. Byrn, A. M., Published by Munn & Co., 361 Broadway, New York City. 476 pages profusely illustrated. Price \$3.00. The author in his preface acknowledges that he is undertaking an ambitious task and disclaims any effort to a complete review of the progress of invention during the nineteenth century, recognizing that such an effort would fill many volumes the size of the very interesting one he has prepared. It would be very easy to criticize the author of such a work for omissions, but it is only fair to judge by what he has done and not by what might have been done, as the field covered by the subject is practically limitless. In the first chapter an interesting perspective view is taken of inventions during the nineteenth century, and in Chapter II, the author gives a very interesting chronology of its leading inventions. Then follow 33 chapters under the following heads: Electric Telegraph; Atlantic Cable; Dynamo and its Applications; Electric Motor; Electric Light; Telephone; Electricity, miscellaneous; Steam Engine; Steam Railway; Steam Navigation; Printing; Typewriter; Sewing Machine; Reaper; Vulcanized Rubber; Chemistry; Food and Drink; Medicine, Surgery and Sanitation; Bicycle and Automobile; Phonograph; Optics; Photography; Roentgen or X-Rays; Gas Lighting. Civil Engineering; Wood Working; Metal Working; Fire Arms and Explosives; Textiles; Ice Machines, Liquid Air. From this list it will be seen that the author has made an interesting selection. The text is most interestingly illustrated and the book both intensely interesting and valuable.

MINERAL LAW DIGEST, by Horace F. Clark, Charles C. Heltman and Charles F. Consaul. Price \$7.50. 538 pages. Callaghan & Co., Chicago, Ill. This Digest contains a section of the United States revised statutes. Under the section given there are arranged the regulations of the Land Office pertaining to the subject matter of that particular section of the statute, and following the regulation is a digest of decisions upon points arising under that particular section of the statute. Part II of the book contains a Manual of Procedure intended as a guide to all mining claimants in the various steps necessary to secure a patent for his claim. Part III contains samples of the various "forms" used in connection with the location of mineral claims. The text is well printed and well arranged, and the book is a very handy reference book for any one wishing to attain a general idea of the subject of mining claim locations.

THE MINERS MANUAL. United States, Alaska, The Klondike. Callaghan & Co., Chicago, Ill. Price \$2.50. 404 pages. This work is to a certain extent a condensed form of the preceding. It is divided into four parts as follows: Part I. A brief treatise upon the land acquired by location entry with a description of the various steps for the acquisition of the title. Part II. The "Mineral Land Statutes" of the United States with the latest regulations for the Department of the Interior. Part III gives "forms" for use in acquiring and transferring title to mining claims, and includes a chart of mining terms. Part IV gives a general description of Alaska and Klondike.

PERSONALS.

Mr. Guy C. Orme has recently left Mexico and his present address is Owenmore, Croosmolina, County Mayo, Ireland.

Mr. Hugh MacDonald, of Pittston, Pa., for some years past Mine Inspector of the 3rd anthracite district, has been reappointed by Governor Stone for another term.

Mr. Frank Webster, link-belt engineer, has opened an office at 1501-2 Park building, Pittsburg, where he will represent the Link-Belt Engineering Co., of Nicetown, Philadelphia, Pa.

C. W. Pritchett, Jr., who has recently been in assay work in Mexico, has returned to the United States and his present address is Box 393, Denver, Colorado, where he is engaged in mining engineering work.

Mr. Frank P. Kendrick, well known in the lower anthracite mining regions, is now located at Lead Hill, Mo., as Superintendent of the Midland Zinc and Lead Co., with mines and works at Lead Hill, Wright County, Mo.

Professor M. C. Ihlse, for the past seven years Professor of Mining and Geology at the Pennsylvania State College, has resigned from that position to take up new work in connection with the Brooklyn Polytechnic Institute of Brooklyn, New York.

Mr. Spencer Miller, Chief Engineer of the Cableway Department of the Lidgerwood Mfg. Co., New York City, has returned from Europe after a four months' absence. It is understood that his latest invention, the marine cableway for coaling at sea, will be taken up by several of the navies of Europe.

Mr. Edward H. Coxe, for some time past engineer of the Boomer Coal & Coke Company, of Boomer, W. Va., has resigned his position to take effect November 30, and has accepted a similar position with the Jones & Adams Company, of Chicago, Ill., operating mines at Caltin and Springfield. Mr. Coxe will reside at Springfield.

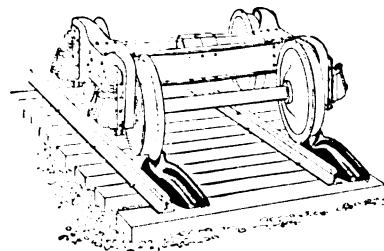
Captain R. G. Dill, who is thoroughly conversant with the mining interests of the West has been made mining editor of the *Denver Times*. Captain Dill has had long experience both in the mining field and in newspaper work, and the *Times* promises, under his direction, a daily department of mining intelligence superior to anything yet attempted in the State.

One of the latest reported trusts or consolidations in the mining and metallurgical line, is a company known as the Allied Cyanide Companies of America. This is a combination of the Gold and Silver Extraction Company of America, Limited, and the Cassel Gold Extracting Company, Limited, of Glasgow, Scotland. The capital is said to be £110,000, divided into 110,000 shares at £1 each; 35,000 of these shares to be preferred. The directors are Wm. Forrest of the McArthur-Forrest process, J. R. DeLamar the well known mining man of the West and Northwest, and Henry A. Jones, Managing Director of the Cassel Gold Extracting Company. The company is to be under British management with an advisory board in Denver, Colo., consisting of the Messrs. Hugh Butler, W. H. James, Philip Argall, and Geo. A. Anderson, the latter to be general manager. It is also rumored that the combination may include the manufacturers of the cyanide, so as to embrace all branches of the business of extracting gold by the cyanide process.

Alexander Car Replacer.

A derailed car is hard enough to handle above ground but underground the difficulties are multiplied many times owing to lack of side room, low roof, poor light and the many other disadvantages incident to underground haulage.

The Alexander engine and car replacer, here illustrated shows a very neat and efficient device for quickly placing a derailed car back on the track again. These replacers are in use on a large number of the railroads in the United States and foreign countries and the testimonials of a large number of users testify to their efficiency. The replacers are made in three sizes, the two smaller sizes being particularly applicable for mine use. The No. 2 replacers weigh 140 lb. per pair, apply to rails $4\frac{1}{2}$ to $5\frac{1}{2}$ inches high and sell for \$16 per pair. The No. 3 weigh 50 lb. per pair, apply to a rail $4\frac{1}{2}$ inches high and sell for \$12 per pair. A trial pair of these "replacers" will be sent by the Alexander Car Replacer Manufacturing Co., of Scranton, Pa., freight prepaid to any point east of the Missouri River.



CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Title to Mining Claim.

Editor Mines and Minerals:

SIR:—I have a mining claim on Sec. 32 School Land in the State of Utah which the State is about to sell. I am not prepared with means or work done to apply for a Patent, or to contest with the State unless I have to. If I buy the land of the State will it give me a good title to my mining claim or would I still have to defend myself against prospectors by getting mining title from the United States.

Yours truly,
J. H.

Carbon County, Montana.

Editor Mines and Minerals:

SIR:—This is the Carbon county of Montana, and contains large deposits of high grade lignite coal as at Red Lodge, bituminous as at Bridger and semi-anthracite as at Carbonado. They are at present drilling for oil in the southwestern part of the county, with every prospect of success. The mineral deposits in this section border on the southwestern part of this county and from thence down into Wyoming. The shaft here is 900 ft. from top bunton to top of coal, vein 5 ft. thick; tippie built for the Anaconda Copper Mining Co., by Gillett-Herzog Co., of Minneapolis is suitable for double deck cages and is 115 ft. from ground to sheave wheels. All construction is of steel and brick. The mine was only recently opened, and the farthest distance from shaft is 1,300 ft. There have been some recent valuable discoveries of copper deposits in the Sun Light district, southwest of here. An analysis of Carbon coal is as follows: Fixed carbon, 46.76; volatile matter, 40.51; ash, 10.73; sulphur, .20; moisture, 1.80.

Carbonado, Mont.

Yours truly,
E. C. S.

Machine Mining in Illinois.

Editor Mines and Minerals:

SIR:—Kindly inform me of the present condition of machine mining in Illinois and Iowa and under what conditions it is carried on.

Birmingham, Ala.

Yours truly,
THOMAS JONES.

Mr. Herman Justi, Commissioner of the Illinois Coal Operators' Association, has kindly answered this question as follows:

"Our current State agreement with the miners' union fixes the machine differential at 10 cts. in the Danville district and 7 cts. throughout the balance of the State. I believe a good many if not all the mines in the Danville district have discontinued the use of their machines on account of the hostility displayed by the individual miners, and not on account of any action taken by the union. The use of machines has been discontinued at other points in the State, though at how many mines I could not say, because of the smallness of the differential, some operators claiming that 7 cts. was not sufficient to cover repairs; in fact it only amounts to 6.4 cts. because there is no charge for pick sharpening in the machine mines, whereas in the hand mines there is a charge of $\frac{1}{2}$ cent for blacksmithing. However, there are new machine mines being opened in several districts.

"We are not specially posted in regard to Iowa, though it is my understanding that machines have never been used extensively, if at all, in that State on account of the thinness of the seams and the limited areas of workable coal."

When we visited the mines of the Danville district in June, 1900, there were no machines running but we are informed that since that time several of the mines have resumed their use.

British Columbia Boundary District.

Editor Mines and Minerals:

SIR:—The mining outlook in the Boundary district of British Columbia is steadily improving now that several of the mines have entered upon the shipping stage. The aggregate tonnage of ore sent out during four or five months ending September 30 exceeds 25,000 tons. About half of this quantity was shipped

during the month of September. Both mining and transportation facilities have been and are still being improved, and provision for treatment of the ore is also being made on a larger scale. The Trail smelter is now in shape to treat more ore than at any previous time, whilst the Granby smelter, at Grand Forks, B. C., which started on August 21st last with one 300-ton stack, now has a second furnace of similar capacity ready to be blown in. The buildings, ore bins, railway trestles and tracks, etc., for the British Columbia Copper Company's smelter at Greenwood are about completed and the machinery for the plant is arriving and is being installed. This smelter will probably be ready for operation before the close of the current year. The Standard Pyritic Smelting Company will begin the erection of its smelter near Greenwood on October 1st and expects to have it completed in December next. These several smelters should be fully equal to all ordinary requirements of the district until more mines shall have been opened up and the output of ore considerably increased.

The principal copper-gold mines of the district are the Knob Hill and Old Ironsides group (owned and jointly operated by what are known in Canada as the Miner-Graves companies); the Mother Lode, owned by the British Columbia Copper Company, of New York; and the B. C., which is the property of the B. C. Chartered Company, of Montreal, Quebec. There are numerous other properties, some of which have shipped a comparatively small quantity of ore, that are promising, but speaking generally their financial backing is not yet strong enough to ensure their being developed on a scale sufficiently large to demonstrate within a reasonable time whether or not they will make permanent mines. Of course there are several exceptions, as will next year be demonstrated by three or four being added to the list of regular shippers. Besides these copper properties there are some with ore carrying values chiefly in gold. Prominent among these is the Jewel, in Long Lake camp, in which a fine gold-quartz ledge has been opened up to a depth of 350 feet. The English company owning this mine intends putting in a stamp mill and probably a cyanide plant, but the latter will be determined by the results obtained from ore now being sent to chemical works near Rossland for treatment.

The Old Ironsides and Knob Hill are together giving employment to 170 men. A new 10-drill air compressor has lately been added to the plant on these mines and after this shall have been put in operation the working force will be increased to the full capacity of the mines to employ miners to advantage. It is anticipated that there will soon be between 200 and 250 on the payroll. The No. 2 shaft on the Old Ironsides is down 400 feet, and altogether there have been done in underground development of this group about 9,000 feet of work. Ore shipments to date exceed 14,000 tons.

Some 65 men are at work on the Mother Lode. Its main shaft is 325 feet in depth and much development work has been done on the 200 and 300-foot levels, especially on the former. A big shoot of ore has been shown by drifts and cross-cuts to be from 80 to 100 feet in width and 400 feet in length, passing thence underfoot from the 200. It has been entered on the 300 ft. but not explored for any great distance along its length at this lower level. A commencement has been made to sink the shaft to the 500 ft. level, which will be reached early in the new year. Altogether development work done in this mine approximates more than 5,000 feet.

The B. C. mine was the first in the district to ship regularly to the smelter. Its total output to date is about 10,000 tons. Its present depth is only 272 feet, with ore stopes on three levels, the deepest being 260 feet. Preparations are now being made to sink deeper and in other ways to more extensively develop this mine, for which its present owners are understood to have two years ago paid \$300,000.

The larger mines in this promising district are in the charge of mining engineers who have had practical experience in some of the most important mining camps in the United States, so they are in fully capable hands. A large amount of capital has already been spent in building railways, erecting smelters and equipping and developing mines, but the outlook is very favorable for an ample return resulting.

Greenwood, B. C.

Yours truly,
E. JACOBS.

Outside or Inside Packed Pumps.

Editor Mines and Minerals:

SIR:—Thanking you for the excellent exposition of the principles and action of pumps in the article on "Draining and Pumping in Mines," in your September issue of MINES AND MINERALS, I again with many others, would enjoy a few words from you, or if you prefer, to have it discussed in your correspondence column, on the following questions:

Is there any difference in the action of the atmospheric pressure on a common plunger pump with one end of the plunger exposed to the atmosphere, and on a central, outside or inside

packed plunger which has neither end exposed to the air? Both kind of pumps being double acting.

Is there any difference in the pressure or resistance from the bottom valve to discharge point; and consequently, greater strength of material required in one pump than in the other? If a mathematical illustration is to be given, let us have it on a pump of the following dimensions: Diameter of pump 10 inches, stroke 3 feet, lift of pump from sump to discharge point 100 feet, with pump set 23 feet above the water in the sump. We place the pump at this point because a mine pump with less than 15 or 20 feet from the general level of the water in the sump to the bottom of the top valves has too little sump storage room or reserve to give practical satisfaction.

As these central packed pumps are getting into much more general use, it would be of interest to mining men to know their advantages and disadvantages. Very truly yours,
Pittston, Pa. D. W. EVANS.

There is no difference in the action of the atmospheric pressure in the two styles of pumps given. In both cases the pressure of the atmosphere is exerted alike upon the water column at its point of discharge, and upon the surface of the water in the sump or basin. This atmospheric pressure becomes a positive pressure exerted against each side of the piston or plunger. This is the case whether one end of the plunger is exposed to the atmosphere or not. The only difference that occurs in reference to the pressure under which the piston or plunger of a pump moves, is in the case of single acting or double acting pumps. In both of these types the atmospheric pressure is exerted alike upon both ends of the plunger, either acting directly upon the plunger itself or through the water column. Thus, if one end of the plunger is exposed to the atmosphere, the atmospheric pressure acts upon that end of the plunger directly; but where the end of the plunger is not exposed to the atmosphere, the atmospheric pressure acts through the water column. In double acting pumps one end of the plunger may be exposed directly to the atmosphere, as in the case in those pumps using two plungers connected by outside yokes and rods, both plungers moving in the same direction. This is the common form of the Jeaneville pumps and other types, and these are outside packed. When the plunger is inside packed, neither of its ends is exposed directly to the atmospheric pressure. In single acting pumps on the other hand, one end of the plunger is always exposed directly to the atmospheric pressure. In neither of these cases, however, is the pump required to lift the atmospheric pressure in addition to the water column. The only difference between the two types of action, double acting and single acting pumps, is that in the single acting pump the pump is required to lift but one water column at a time. For example, in the forward stroke of a single acting pump the pump lifts the water column at its discharge end, while in the backward stroke it lifts the water column at its suction end. The weight of either one of these two columns is held alternately by its respective valves while the pump is lifting the other column. In this case only, is there any decrease or increase of the load upon the plunger of the pump due to its style of action. The atmospheric pressure in no case acts to increase the load upon the pump or to decrease it; as far as the water cylinder is concerned.

The action of the total or absolute pressures exerted upon the two ends of the piston or plunger of a pump, in both the single acting and the double acting pumps, will be more clearly understood by tabulating these pressures as below. All of these pressures are exerted against the plunger or piston, except only the pressure of the water column at the suction end of the plunger, which is exerted in a direction away from the plunger. We may thus speak of these pressures as being positive or negative according as they are exerted toward the plunger or away from it. We have indicated these two kinds of pressures by the positive (+) and negative (—) signs.

SINGLE ACTING PUMPS.			
	Discharge End.		Suction End.
Forward stroke	+ Atmospheric pressure + Water column		+ Atmospheric pressure
Backward stroke	+ Atmospheric pressure		+ Atmospheric pressure — Water column
DOUBLE ACTING PUMPS.			
	Discharge End.		Suction End.
	+ Atmospheric pressure + Water Column		+ Atmospheric pressure — Water column

In every case the effective pressure upon the plunger or piston of a pump, or the effective head under which the pump operates, is the difference between the absolute or total pressures upon the two ends of the plunger or piston. We observe that if we subtract the total pressure upon the suction end from the total pressure upon the discharge end, in either of these types, we obtain the pressure head against which the pump is operating. Doing this we find that in single acting pumps the pressure head

in the forward stroke is the water column above the pump, or the discharge column, while in the backward stroke the pressure head is the water column below the pump, or the suction column. In double acting pumps we find the effective head to be the sum of the two water columns or the total water column from the sump level to the point of discharge at the surface. The atmospheric pressure upon the two ends will be observed to balance in any case.

The statement that central packed pumps are coming into more general use may be questioned. This class of pumps for mine work has few if any advantages, while its disadvantages are numerous. It is true for light pressures inside packing does fairly good work. The only positive advantage in its favor that we recall at present is the fact that sometimes one central plunger packing takes the place of two outside plunger packings, but even then a small packing is required around the plunger stem. When inside packing is used the condition of the packing is not readily observed; water may leak past the plunger from one side of the piston to the other without being observed. This will greatly reduce the efficiency of the pump, and the cause may be unknown for a long time. Outside packing is readily renewed at any time with little trouble and delay, while the renewal of inside packing requires the drainage of the pump and the removal of the cylinder head.

Correction.

The article upon the "Compressed Air Locomotive," by Mr. H. K. Myers, which appeared in the November issue of MINES AND MINERALS, has been very favorably received and commented on. The following typographical errors should, however, be noted in the article: The formula for tractive effort (p. 188) should read $\frac{d^2 \times l \times x p}{D}$, not $\frac{d \times l \times x p}{D}$. The formula on page 189 should be $V = V' \frac{p}{p'}$, not $V = V' \frac{p}{p' + p}$. $V = 975 \frac{130}{650 - 130} = 244$, not $V = 975 \frac{130}{650 + 130} = 244$. Omit inch marks ("in" or ") wherever used in the article in giving amount of cut-off. Page 189, 1st line, should be .98 not .95.

Attention has also been called to the fact that some of the arithmetical work is not exact. Mr. Myers intimated this by his statement that his calculations were made with the slide rule, and although the results published are accurate enough for all practical purposes; still lest such values may be misleading to some, the following slight changes in arithmetical values may be noted:

Page 189, first column, 6th paragraph, should read [5,400 × 6 = 32,400, but 32,000 would almost invariably be assumed.] We will, therefore, assume the necessary weight of the locomotive to give the proper adhesion as 32,000 lb., and we calculate that the tractive effort necessary to haul itself up the 3.5 per cent. grade would be 3.5 ÷ .5 = 4 per cent. (.5 per cent. covering the friction of the locomotive on the level) of 32,000 lb., or 1,280 lb., to which we add the necessary drawbar pull to haul the desired load, 1,280 + 5,400, and have a total tractive effort of 6,680, which is about the limit of our locomotive on dry rail with sand.

By consulting the table No. 1 we see that, at 100 lb. working pressure, a 10 in. × 14 in. 26 in. driver locomotive has a maximum tractive effort at $\frac{1}{4}$ cut-off, which is practically full stroke, of 5,280 lb., and by dividing this into our necessary tractive effort, we find that the necessary working pressure would be about 130 lb. [$\frac{5280}{40} = 132$ but 130 would ordinarily be assumed.]

Page 189, 2nd column. The length of haulage should be 5,370. In answer to an inquiry as to how Table No. 1 was calculated, Mr. Myers says:

"In making calculations of Table No. 1 I used formula $T. E. = \frac{d^2 \times x p \times l}{D}$ in which x is as follows: For $\frac{1}{4}$ cut-off, .98; $\frac{1}{2}$, .95; $\frac{3}{4}$, .88; $\frac{1}{4}$, .80; $\frac{1}{2}$, .68; $\frac{3}{4}$, .51; and $\frac{1}{4}$, .31 and $p = 100$. The relative values of x are .98, $\frac{1}{2}$, .96, $\frac{1}{2}$, .90, $\frac{1}{2}$, .83, $\frac{1}{2}$, .72, $\frac{1}{2}$, .58, $\frac{1}{2}$, and .40, $\frac{1}{2}$ for expansion of air and in order to give a safe value to x I worked from absolute pressures.

"Thus, with a gauge pressure of 100 the absolute is 115 lb. and for $\frac{1}{4}$ cut-off whose corresponding factor is .40 we have .40 × 115 = 46 lb. less 15 lb. at atmospheric pressure gives 31 as the M. E. P. for $\frac{1}{4}$ cut-off. In the late cut-offs this is a matter of little importance, but as a matter of safety should be considered."

South Pass, Wyoming.

Editor Mines and Minerals:

SIR:—The past summer has been one of considerable activity in the mining fields of the West, and the South Pass country has had its portion considering the fact that it is isolated from any railroad. Since my former letter the Carrisa Mine—now incorporated under the name of the Federal Gold Mining Company—

has opened up three large ore shoots carrying high values in gold. The property is now opened up to a depth of three hundred feet, with levels driven each way on the vein. The mill is run one shift owing to a scarcity of water; a thing that has never occurred in this section before. Mr. Charles Van Sickle, one of the principal owners of the mine, is here at present writing. He is making arrangements for the spring work, which will be carried on under the management of B. U. Tibbals. East of the Carrisa mine and joining it is the Dewey property operated by the New England Company, the same company owns or controls the Smuggler-Union property in Colorado. Mr. Geo. Leighton, the manager, has a small force at work, developing the property, but as it is in litigation no one not interested can learn anything as to the extent and richness of the ore bodies that are opened up. Two miles east and in the same belt is the Mary Ellen mine, incorporated and worked under the control of the South Pass M. & M. Co. This property is owned principally by Colorado men. The mine lies in a granitic porphyry zone—that has intruded up through the gneissic schists; it has a varying width of from a very few inches to two and one-half feet, and is composed of a white quartz containing free gold in paying quantities as well as iron sulphide rich in values. Mr. J. P. Ibsen, of Denver, Colo., the manager, has sunk the shaft down to a depth of two hundred feet; and is now drifting both ways on the vein with a view of opening up four rich shoots that are known to exist. Since taking charge of the property this spring he has erected on the ground a Huntington mill and hoisting plant. Both plants are under one roof.

On the same mineral belt and about one-half mile east of the Mary Ellen property is the St. Louis. This mine is worked under lease and bond by Messrs. Carr, Hoisington & Co. They extracted several tons of high grade ore this season which they have just finished running through the Sherlock-Marrin mill above South Pass. The lessees have opened up a large body of low grade ore which can be successfully treated by the Waugh-Bignell dry concentrating process, but as Messrs. D. E. Thompson, Bignell and Waugh have not erected a custom plant the lessees will not take out the ore until spring.

The Garfield mine is on a different mineral belt from the former mentioned mines, but the belt intersects the Carrisa mineral zone at or near the east end line of the Carrisa mine and from there it has a more northerly trend than the first mentioned belt. This property has been worked more or less for the past thirty years and has been very productive in gold. Mr. D. E. Thompson and E. Bignell, superintendent of the B. & M., are interested in the property and have a bond and lease on it. They have erected a Chilean mill and have a Waugh-Bignell dry concentrator of twenty tons capacity at work. The mine and mill are equipped with a complete electric plant of eighty H. P. From a test of the Garfield ore which assayed \$8 per ton they succeeded in raising the value of the concentrates up to \$1,059.55 per ton, leaving 83 cents value in each ton of tailings run through the concentrator. As there are large bodies of low grade ore in this and other properties, the Waugh-Bignell process will do much toward bringing in capital from the outside. The geological features of this mine have been well spoken of by Professors Hayden, Comstock, and others.

The Rose mine is situated about one-half mile west of the Garfield (Buckeye) mine and is therefore one and one-half miles west of Atlantic City. This property is being worked by Mr. R. M. Ricketts, who has opened up the vein in such a manner as to show a large body of high grade gold ore that averages over one hundred dollars per ton. Some of the ore is said to carry tellurium in good values. Like all other mines in this field, the vein is lying in the metamorphic rocks.

The Granier placer mines that have been laying idle for a number of years have changed hands. Mr. D. G. Cahoon, of Potsdam, N. Y., having succeeded in inducing a rich syndicate to work the property, and under the superintendency of Messrs. Giessler and Ibsen the many miles of ditches and flumes have been put in repair and all arrangements to work the placers next spring have been made. The gravel covers an extensive area and is very rich. Besides the miles of valley along the Rock Creek, there are thousands of acres of a glacier deposit which carries values.

The Granier placers were first operated fifteen years ago, by a company of Frenchmen, under the management of Mr. Emile Granier, of Paris, France. The company spent large sums of money constructing ditches, flumes, and dams, but from some cause the ground was never made to pay though it was rich in gold; some of the ground running as high as thirty dollars to the cubic yard. Though Mr. Granier tried hard to get experienced placer miners, he failed as subsequent facts, which have come to light, prove. The new company can make the property pay if the same is handled intelligently and in a business like manner. The entire South Pass mining region is situated on a high

plateau near the summit of the Rocky Mountains and is composed of an igneous and metamorphic formation, as late tests have demonstrated, for numbers of samples sent to the School of Mines, of Colorado, and other leading institutions of the country, have been tested and pronounced to be dolomite, gneiss, diorite, phonolite, granite, and syenite. What developments will prove this section to be, remains to be seen. A move is being made to have Mr. Arthur Lakes, of Denver, Colo., come in here next spring and examine and report on the country.

South Pass, Wyo.

Yours truly,
ED. HARRIS

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

- M. C. BULLOCK MFG. Co., Chicago, Ill. "Hoisting Machinery," 32 pages.
- A. LESCHEN & SONS ROPE Co., St. Louis, Mo. "Hercules Wire Rope," folder.
- M. C. BULLOCK MFG. Co., Chicago, Ill. "Bullock Diamond Drills," 4 pages.
- AMERICAN STEEL & WIRE Co., Worcester, Mass. "Springs." Catalogue of 60 pages.
- SAGINAW COAL Co., Saginaw, Mich. "What Foreigners Think of Saginaw Coal," folder.
- B. F. STURTEVANT Co., Boston, Mass. "Steel Plate Fans," Third Edition, 132 pages.
- DIAMOND DRILL & MACHINE Co., Birdsboro, Pa. "Jackson Belt-Lacing Machine," 20 pages.
- THE RISDON IRON WORKS, San Francisco, Cal. Catalogue No. 10, "Pumping Machinery," 120 pages.
- BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. "Recent Atlantic Type of Locomotives," 84 pages.
- The Alexander Engine & Car Replacer Mfg. Co., Scranton, Pa., catalogue of Replacers and Wrecking Frogs.
- KEUFFEL & ESSER Co., New York City. 482 pages. Catalogue of drafting and surveying instruments and supplies.
- C. W. HUNT COMPANY, 45 Broadway, New York City, "Electric Locomotives for Light Railways," 5 page pamphlet.
- THE SHELBY ELECTRIC Co., Shelby, O. Pamphlet No. 17, "Useful Light," 40 pages. "Lamp Efficiencies," 31 pages.
- JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. "Graphite," 4 page circular. "Dixon's Silica-Graphite Paint Folder."
- "FEDERAL BATTERY SALT," AND "HOLD FAST BELT DRESSING" circulars of the Frank S. De Ronde Co., 52-54 John St., New York.
- TALISMANIC COMPANY, 95 William St., New York City. "Talismanic Belt Clinch Rubber Facing, Rope and Cordage Preserver," folder.
- "A BRIEF HISTORY OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY," Chicago, Ill., by Luis Jackson, Industrial Commissioner, 16 pages.
- HOOPER PNEUMATIC MILLING COMPANY, Baltimore, Md. "The Concentration of Mineral Bearing Ores by the Hooper Pneumatic System," 16 pages.
- B. F. STURTEVANT Co., Boston, Mass. "The Sturtevant System of Heating, Ventilating and Moistening Textile Manufactories," 36 pages.
- CHISHOLM, BOYD & WHITE Co., Chicago, Ill. "Improved Machines and Process for Making Briquettes and Eggettes," 15 pages. "Does Briquetting Pay?" 8 page circular.
- WESTINGHOUSE ELECTRIC & MANUFACTURING Co., Pittsburg, Pa. Circular No. 1032, "Westinghouse No. 56 Railway Motor," 15 pages. Circular No. 1033, "Direct-Current Engine-Type Generators," 7 pages.
- THE JEFFREY MFG. Co., Columbus, O. "Electric and Compressed Air Coal Mining Machinery," 93 pages, printed in English, French and German for the Paris Exposition. "The Jeffrey Patented Retarding Coal Conveyor," circular, 6 pages.
- GENERAL ELECTRIC Co., Schenectady, N. Y. Catalogue No. 7531, "Instruments," 24 pages. Bulletin No. 4230, "List of Poly-phase Power Plants," 16 pages. Bulletin No. 4231, "Electrostatic Ground Detectors," 4 pages. Bulletin No. 4232, "Small Continuous-Current Stationary Motors, Type CA," 6 pages.
- WESTINGHOUSE ELECTRIC AND MANUFACTURING Co., Pittsburg, Pa. Circular No. 1,034. Direct-Current Engine Type Generator, 250 volts, particularly constructed for supplying power to motors operating machine tools, cranes, elevators, ventilators, pumps, rolls, drills, cutting machines, etc., in factories, mills and mines. These generators also permit of the operation of both arc and incandescent lamps from the motor circuit.

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Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for December.

QUES. 619.—Siphoning From a Shaft.—We have a shaft 50 feet in depth sunk on a hill. The shaft is making 4,000 gallons of water per hour. At a short distance from the mouth of the shaft is a steep ravine that descends to a river 100 feet below the depth of the shaft. It has been suggested that a siphon could be used advantageously to handle this water. If this accords with what you would advise please say so, but if not, state how you would proceed to handle this water if you were placed in charge of the mine.

QUES. 620.—Will Ventilation Cease if Fan Is Stopped?—We have a mine ventilated by means of two shafts, a downcast shaft having a depth of 300 feet, and an upcast shaft whose depth is 500 feet. The ventilator is a blow-down fan, which furnishes a current of 40,000 cubic feet of air per minute in the mine. The development of the mine has been such that the length of its airways from the foot of the downcast to the foot of the upcast shaft is practically 50,000 feet; the double-entry system being used. If the fan is suddenly stopped for repairs will the air current continue to circulate through the mine, or will all circulation in the mine cease?

QUES. 621.—Gob Fires In Abandoned Workings.—The mine of which I have charge is troubled with gob fires in the abandoned workings near the shaft bottom. The fire walls and brick stoppings which we have used to close off these abandoned workings are only partially effective. Owing to shaly roof and porous character of the coal, sufficient air is still supplied to the workings to render the fire a constant menace to the mine. The mine is worked on the room and pillar system, with double entries, and is ventilated by means of an exhaust fan. Will you kindly suggest what in your opinion would be the most effectual manner of treating this fire both with respect to the present and future good working of the mine?

QUES. 622.—Blasting In Presence Of Gas.—(a) Explain the danger incident to blasting with ordinary black powder in gaseous workings. (b) How is this danger largely overcome in the use of dynamite for blasting? (c) Describe the class of explosives known as flameless powders.

Compare these three forms of explosives and give their relative advantages and disadvantages in blasting coal.

QUES. 623.—Effect Of Placing A Regulator, Power Constant.—A certain fan is maintaining a circulation of 50,000 cubic feet of air in a certain mine in two splits of equal length; split A being 4' x 12', and split B 6' x 12' in cross section and no regulator being used. It is now desired to reduce the quantity of air passing in split B to 20,000 cubic feet by the introduction of a regulator. Assuming that the power upon the air at the point of split remains unchanged, what effect will the placing of this regulator have (a) upon the air passing in the two splits, (b) upon the speed of the fan?

[NOTE.—In assuming that the power applied to the air at the mouth of the splits remains unchanged it is supposed that the splits are at the foot of the downcast shaft, and the resistance of the shafts is ignored; the increased resistance of the fan due to the passage of a larger quantity of air per minute is also ignored, that is to say, it is assumed that the same work is absorbed by the fan when a larger quantity of air is passing, or that the efficiency of the fan remains unchanged.]

QUES. 624.—Setting The Valve Of An Engine.—Describe the manner of setting a valve of an engine. State also in what cases you would use an early cut-off, and give sketch showing the position of the valve at the time of cut-off on the following stroke of the engine.

QUES. 625.—Use Of The Injector For Raising Water From A Shaft.—We have been using an injector at the bottom of the hoisting shaft in our mine for lifting the water from the sump to the surface. The injector is placed at the height of 8 feet above the level of the water in the sump. The steam is supplied through a 2 inch pipe carried down the shaft. The depth of the shaft is 250 feet. We often experience considerable trouble in starting the injector after it has been idle for a few hours. Will you kindly explain the reason for this difficulty? The trouble seems to be that the injector does not catch the water. Explain the correct position and manner of starting the ordinary Harrison steam injector when used for throwing water from the bottom of the shaft to the surface.

QUES. 626.—Surveying, Two Plumb Lines In A Hoisting Shaft.—We have recently sunk a shaft 200 feet in depth to be used as a hoisting shaft. The shaft is 8 feet wide and 18 feet in length, including the pump or manway. After driving the entries back 100 yards from the foot of the shaft we desire to connect the surface survey with the entry sights below. Describe how this may be done in the most accurate manner possible. The main shaft bottom has a width in clear between timbers of 14 feet; the pump or manway is connected with the air course by means of a cross-cut 7 yards in length; the first break through at the shaft bottom is 25 yards from the foot of the shaft. Give sketch showing position of the plumb lines in the shaft and the manner of connecting the surface and underground surveys so as to give entry sights referred to the same meridian as that used upon the surface.

Answers to Questions Which Appeared in the October and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 612.—Haulage, Load upon Guide Sheaves.—Calculate the load upon the journals of each guide sheave around a curve in a haulage road. The radius of the curve at the center line of track is 48 feet, and the sheaves are set 26 inches from track center, and 4 feet apart, center to center. The tension upon the rope is 6 tons.

ANS.—Referring to the figure, let ab and bd represent the tension in the rope ($6 \times 2,000 = 12,000$ lb.) on each side of the sheave b . Then drawing ac and de to complete the parallelogram of forces, the diagonal be of this parallelogram will represent the resultant of the forces, or the thrust or load upon the journals of the sheave b . Now, let c be the center of the curve of which ab and bd are chords, and draw cf bisecting the chord ab ; draw also ag bisecting be . Then, since the parallelogram is equilateral, ag is perpendicular to be ; and from the similar triangles abg and caf , we have the proportion $bg : ab :: af : ac$. But, by construction, bg is one-half the load on a sheave; and af is one-half the distance between the centers of the sheaves ($\frac{4 \times 12}{2} = 24$ in.)

while ab is the load on the rope (12,000 lb.) and ac is the radius of the curve through the centers of the sheaves ($48 \times 12 - 26 = 550$ in.). Substituting values we have finally for the entire load on the journals of each sheave, denoted by L ,

$$L = 2 \left(\frac{24}{550} \right) \times 12,000 = 1,047.2 + \text{lb.}$$

Prizes were awarded in November issue as follows:

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—THEODORE SIMONS, Roseland, B. C.

QUES. 618.—Energy of Fly Wheel.—The fly wheel of an engine measures 6 feet in diameter, out to out, and 8 inches on the face, the thickness of the rim being 3 inches. If this wheel is set upon the crank shaft of a 12" x 16" engine, at what speed will the stored energy of the wheel equal the power of the engine, assuming a mean effective cylinder pressure of 50 pounds per square inch?

Ans.—Let u = foot-pounds of work per second,
 n = mean effective cylinder pressure (lb. per sq. in.),
 l = length of stroke (feet),
 a = area of piston (sq. in.),
 n = number of revolutions per second.

Then, $u = 2 \pi a n = 2 \times 50 \times \frac{1}{2} \times .7854 \times 12^2 \times n = 15,080 n$.
 Since 1 cubic inch of iron weighs .26 pound, the weight of the fly wheel is $.7854 (72^2 - 66^2) \times 8 \times .26 = 1,352.6$ lb.; the outer and inner diameters of the rim being 72 and 66 inches, respectively.

[Supposing the entire mass of the wheel to be concentrated at the center of gravity of the cross section of the rim of the wheel, or to revolve in a circle whose circumference is 3.1416×5.75 = say 18 ft.; the energy of the fly wheel is found as follows:

Let u = energy of fly wheel (foot-pounds per sec.),
 m = mass of wheel considered as concentrated at the center of gravity of the cross section of the rim,
 W = weight of wheel,
 g = force of gravity (32.16),
 v = velocity of center of gravity of rim (ft. per sec.).

Then,

$$u = \frac{mv^2}{2} = \frac{Wv^2}{2g} = \frac{1,352.6 \times (18n)^2}{2 \times 32.16} = 6,813.5 n^2.$$

But the energy of the fly wheel is to equal the power developed by the engine.

Therefore, $6,813.5 n^2 = 15,080 n$, or, $n = \frac{15,080}{6,813.5} = 2.213$

revolutions per second.

Linear velocity of a point at the center of gravity of the section of the fly wheel rim = $2.213 \times 18 = 39.834$ feet per second. J. N. S. WILLIAMS, Honolulu, Hawaiian Islands.

QUES. 620.—*Principle of the Safety Lamp.*—Explain clearly and simply the principle of the safety lamp, or tell in a few plain words what prevents the flame of the gases burning within the lamp from passing through the apertures of the wire gauze.

Ans.—The claim to safety in all so called safety lamps is based upon these lamps being so constructed that the flame under ordinary conditions is prevented from coming in contact with the gaseous atmosphere surrounding the lamp. This is accomplished by enclosing the flame of the lamp within a cylinder of fine wire gauze. It has been found by experiment that a flame will not pass through the small apertures of the cool wire gauze except by increased pressure. [As for example, when the flame is blown by a rapid current of air against the gauze, or when an explosion of gas occurs within the lamp.] The theory is that the gas burning within the lamp as it passes through the wire gauze is divided into little streams of gas by the wires of the gauze, there being 28 wires to the inch. [$28^2 = 784$ openings per square inch.] Each little stream of gas is cooled below the temperature of ignition, by its proximity to the cool gauze. The flame is thereby prevented from passing through the gauze as long as the latter remains cool. The wires of the gauze cool the burning gases by absorbing enough of their heat to reduce the temperature of the burning gases below the temperature necessary for ignition.

Gas will not ignite from a spark or a red hot wire, but requires direct contact with flame; but a red hot gauze will soon allow the passage of the flame of the gas burning within the lamp, and this will ignite the gases outside of the lamp. Therefore, whenever the gauze of a safety lamp becomes hot the lamp must be removed to a pure atmosphere and allowed to cool.

[There is always a thin layer of gas that does not burn, between any cool surface and a flame. The temperature of this thin layer of gas that does not burn, has been lowered, by the absorption of its heat by the cool surface, below the point necessary for the ignition of the gas. Flame does not touch a cool surface.] D. J. LEWIS, Helvetia, Pa.

Second Prize.—THOMAS O'BRIEN, La Salle, Ill.

QUES. 621.—*Measurement of Water Flowing in a Ditch or Flume.* The weir opening of a certain flume is exactly 72 inches in width, and the depth of water flowing over the weir is 5½ inches. Calculate the number of gallons of water flowing over the weir per minute. Desiring to check the measurement of the flow in this flume, a little piece of board was floated upon the surface of the water in the flume, and the time observed that it took to pass between two points 50 feet apart. The observed time was 36 seconds. The full width of the flume in the clear is 90 inches, and the depth of the water 8 inches. Show how closely this latter observation checks the first calculation.

Ans.—Let Q = discharge (cu. ft. per sec.),
 l = length of weir (ft.),
 h = effective head (ft.); that is to say, the vertical distance from the sill over which the water flows to the surface of the still water above the weir.

Then by Francis' formula $Q = 3.33 l \sqrt{h^3}$. Now, if we let Q_1 equal the discharge in cubic feet per minute, and l_1 and h_1 are taken in inches, this formula then becomes $Q_1 = 0.4 l_1 \sqrt{h_1^3}$. Substituting the values given in the question we obtain $Q_1 = 0.4 \times 72 \sqrt{5.25^3} = 346.44$ cu. ft. per min., or, 2,591.4 gal. per min.

To check this we have a float which traverses fifty feet in thirty-six seconds, or, $\frac{50}{36} = 1.389$ feet per second on the surface. But the surface water of a stream flows faster than the water at the bottom or sides, the average velocity being 83 per cent. of the surface velocity at the middle of the stream. Then 83 per cent. of 1.389 equals $.83 \times 1.389 = 1.153$ ft. per sec.; and the quantity of flow is equal to the average velocity times the cross-sectional area of the flume. In this case the cross-sectional area of the flume is $90'' \times 8'' = 720$ sq. in., or 5 sq. ft. And $Q = 1.153 \times 5 = 5.765$ cu. ft. per sec. Then, $5.765 \times 7.48 \times 60 = 2,587.33$ gal. per min., which for all practical purposes checks the first calculation. W. H. SHERBURNE, Cripple Creek, Colo.

Second Prize.—JOSEPH DAVY, Nanaimo, B. C.

QUES. 622.—*Size of Pump.*—Calculate the size of a direct acting pump that will discharge 1,600 gallons of water per minute from a sump at the bottom of a shaft 300 feet deep, assuming the steam cylinder pressure to be 80 pounds per square inch.

Ans.—Assuming for this work a duplex pump, having a piston speed of 100 feet per minute for each cylinder, and assuming an efficiency at the steam end of 75 per cent., and at the water end of say 85 per cent. [This is frequently assumed as only 80 per cent.], and letting

G = amount of discharge (gal. per min.),
 h = height of lift (ft.),
 p = mean effective cylinder pressure (lb. per sq. in.),
 D = diameter of steam cylinder (in.),
 d = diameter of plunger (in.),
 S = piston speed (ft. per min.),

we have, since the weight of a gallon of water is 8½ pounds, for the water end of each pump,

$$8\frac{1}{2} G h = .75 \times 2(p \times .7854 D^2 S);$$

or substituting the values given,
 $8\frac{1}{2} \times 1,600 \times 300 = .75 \times 2 \times 80 \times .7854 \times D^2 \times 100;$
 whence, $D = 20.6$ in.

Again, since there are 231 cubic inches in a gallon, we have,
 $231 G = .85 \times 2(.7854 d^2 S \times 12),$

or substituting the values given, we have,
 $231 \times 1,600 = .85 \times 2 \times .7854 \times d^2 \times 100 \times 12;$
 whence, $d = 15.1$.

We would select the pump of the nearest market size to these dimensions; say for example, a duplex Worthington pump 25'' × 15'' × 15''. [The length of stroke is determined largely by manufacturers, being dependent upon the size of the pump. It is customary to design pumps of moderate lift for a piston speed of 100 feet per minute. As the length of stroke is shorter the pump makes a larger number of strokes per minute and vice versa.]

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—JAMES RADFORD, Springfield, Ill.

QUES. 623.—*Force Required to Open a Mine Door.*—Calculate the force required to pull open a mine door at the shaft bottom, between the main intake and return entries of a mine, the water-gauge reading at the door being 3 inches. The size of the door is 5 ft. × 6 ft., and the position of the handle is 5½ feet from the axis of the hinges. The door is assumed to fit snugly and to be practically air-tight.

Ans.—Area of the door = $6 \times 5 = 30$ sq. ft., ventilating pressure, as shown by water gauge reading = $3 \times 5.2 = 15.6$ lb. per sq. ft.; total pressure on door = $30 \times 15.6 = 468$ lb. The center of this pressure is at the center of the door, or 3 feet from the axis of the hinges, while the position of the handle is 5½ feet from the same. Hence, disregarding friction [the moment of the pull exerted on the handle and the moment of the pressure acting at the center of the door will be equal] when the door is about to open, $5\frac{1}{2} \times p = 3 \times 468$, or $p = 255\frac{1}{2}$ lb. Any force greater than this will open the door.

ROBT. PICKETT, Spring Valley, Ill.

Second Prize.—A. B. JESSUP, Centralia, Pa.

QUES. 624.—*Mine Resistance, How Affected by Splitting.*—When the air current passing in a mine is divided into two or more equal splits, is the resistance of the mine thereby diminished or increased, or does it remain the same after the splitting as before, assuming the power upon the air is constant?

Ans.—Splitting the air in a mine does not diminish the resistance when the same power is applied as before splitting. The same power applied to a number of splits as applied to a single aircourse will produce a larger quantity of air. The power producing ventilation in the single aircourse will produce a greater quantity in a series of splits until the resistance in the splits is equal to the resistance of the original airway.

PETER WELSH, Trauger, Pa.

[Out of the large number of answers received from some of our best contestants, in reply to the above question, only one was correct. Some of these answers said the mine resistance would be increased four times when the number of splits was doubled, basing this assumption on the fact that the quantity of air will be proportionate to the number of splits, and the pressure vary as the square of the quantity. This is, of course, careless reasoning; but the majority of the answers assumed that the mine resistance was indicated by the unit of ventilating pressure (p) and since the pressure decreases the mine resistance would be likewise decreased. One contestant came nearer to the correct answer by showing that if the same power were applied to the airways the velocity would remain constant before and after splitting, but then proceeded to show that p , which he called the resistance, varied inversely as the number of splits. Another reply stated rightly that the resistance of the mine was the pressure producing ventilation, but wrongly assumed that this pressure was the unit of ventilating pressure. The resistance of the mine is always equal to the total pressure producing ventilation. This total pressure (pa) is the unit of ventilating pressure p multiplied by the area; and remains constant for a constant power, in splitting, ignoring shaft resistance and supposing the power applied to the splits to remain constant. The expression for the mine resistance is $pa = k s^2$. This is more fully explained in an article "Conditions in Mine Ventilation," on page 234.]

QUES. 625.—Owing to the cut not being in readiness, the publication of the answer to this question is deferred till next month. Prizes have been awarded as follows: First prize, Theodore Simons, Roseland, B. C.; second prize, Fremont Crane, Spokane, Wash.

QUES. 626.—*Acceleration Against Resistance.*—Can acceleration take place against resistance, and, if so, how is the acceleration to be determined? Does the tractive force of an engine accelerate the motion of a train until a uniform speed is attained, and why does it not continue to accelerate always, or what is the limit to the acceleration in such a case?

ANS.—Acceleration *does* take place against resistance. [When an engine or any body moves from a state of rest to a state of uniform motion, acceleration takes place. When uniform motion has been attained the body would continue to move at this rate forever, by virtue of its own inertia and without the further application of force, were it not for the resistance.] The force of the engine maintains its motion in opposition to the resisting forces, such as the friction and the resistance of the air.

Let m = the mass moved;

f = the acceleration due to the effective force, or the force producing motion;

F = the total force (lb.) applied against the resistance;

R = resistance (lb.).

Then, since the *effective force* or the force producing motion is ($F - R$); [and since the measure of this effective force, or the *unit force*, is a force that will produce a unit of velocity in a unit of mass in a unit of time, or a force that will produce a unit of acceleration in a unit of mass], we write,

$$F - R = mf \text{ or } f = \frac{F - R}{m}$$

This is the expression for acceleration. According as the applied force F is greater or less than the resistance R , the acceleration of the constant mass m will be positive or negative. When F is greater than R the acceleration is positive [and there is a gain in velocity]; when F is less than R the acceleration is negative. We observe there are two limits, in the first case *uniform motion*, in the second case *rest*; the acceleration becoming zero, in each case, when $R = F$.

[It is interesting to observe that since the applied force F and the resistance R are given in pounds, they represent ideal masses in opposition; and whichever way motion takes place, according as the force or the resistance is predominant, the total mass moved m , equals $\frac{F+R}{g}$; and substituting this value for m , we have finally for the expression for acceleration against resistance, $f = \frac{F-R}{F+R} \times g$, which expression is identical with the expression given in MINES AND MINERALS, page 522, June, 1900.]

M. B. SPAULDING, New York City.

QUES. 627.—*Arrangement of Shaft Bottom.*—Describe the arrangement of the tracks, manway, pumps, etc. at the bottom of a shaft 250 feet deep, and making 1,200 gallons of water per hour, the output of the shaft being 1,000 tons per day of 10 hours, and all of the pumping to be done in 4 hours or between shifts morning and evening. Give the size of pump, size of shaft, depth of sump, and length and grade of shaft bottoms. Caging is to be done from both sides of the shaft, and arrangements must be made for cross-caging in case of unequal production. The seam is 5 feet thick and has a good roof. Give sketch or plan of shaft bottoms, showing tracks, plates, manways, pumps, etc.

[This question still remains open.—EDITOR.]

The Exeter Noiseless Gravity Conveyor.

One of the greatest changes which has taken place in mining practice within recent years is in connection with the handling of materials upon the surface. Some form of conveyor is now used at nearly every surface works, and in the development and manufacture of such conveyors the Exeter Machine Works, of Pittston, Pa., has taken a prominent part. The following is a description of the essential features of the standard conveyor as made by this company:

The chain is constructed of drop forged steel links with eyes reinforced and enlarged, thus giving increased strength and wearing surface. A heavy steel bushing or sleeve passes through the links and a steel pin through the sleeve. The wheels rest upon the sleeves and are self-lubricating; the wearing and friction being reduced to a minimum. The buckets are made of pressed sheet steel and are extra heavy. The dumping arrangement is perfectly smooth in its operation, the bucket discharging the load in the opposite direction to the movement of the conveyor.

The loader is another noticeable feature of this conveyor, simple in its operation, and perfectly accomplishing the purpose for which it is intended. It consists of an endless chain carrying V caps; the spaces corresponding to the spaces between the buckets and fitting closely over the edges of the bucket it forms an absolutely endless trough at the loading point. The loader is made either stationary or portable, or, if there are several loading points to be used simultaneously, the loader can be made of sufficient length to reach these different points.

The conveyor is driven by sprocket wheels engaging with the wheels of the chain. All sprockets are made of steel casting and at all angles steel banded traction wheels are employed. All parts of the conveyor are made extra heavy and workmanship and material are first class in every respect.

The Exeter Machine Works are at present installing this system at the 29th St. Station of the New York Gas, Electric Light, Heat & Power Co., and will be glad to furnish more complete details to interested parties.

Central Mining Institute of Western Pennsylvania.

The winter meeting of the Central Mining Institute of Western Pennsylvania will be held in the Court House, Pittsburgh, Wednesday and Thursday, December 19th and 20th. The following has been announced as a provisional program:

FORENOON SESSION, DEC. 19, 1900, 10 O'CLOCK A. M.

1. Minutes of last meeting.
2. Unfinished business.
3. New business.
4. Presidential address—T. B. DeArmit.
5. Election of officers.

AFTERNOON SESSION, DEC. 19, 1:30 P. M.

6. Paper—On Mine Management and Some of its Responsibilities, by Wm. Seddon, Supt. of Mines, Brownsville, Pa.
7. Paper—Would the Establishment of a National Bureau of Mines at Washington Conduce to the Advancement of the Science of Mining Methods and Promote the Interests of the Mining Industry in General, and be of benefit to the Public? by H. H. Stock, editor of MINES AND MINERALS, Scranton, Pa.

FORENOON SESSION, DEC. 20, 1900, 9 A. M.

8. Address—By Alex. Dempster, M. E., Pittsburg, Pa.
9. Paper—Can the Present Mining Methods, (now in general practice) of the Thick Vein District, Pittsburg Coal Field, be Improved Upon? by Joseph Blower, Supt. of Mines, West Brownsville, Pa.

AFTERNOON SESSION, DEC. 20, 1:30 P. M.

10. Paper—On the System of Underground Haulage and Methods of Mining as Installed and in Use at the Windber Mines, by J. S. Cunningham, Supt. of Mines, Windber, Pa.
11. Paper—On the Gasoline Locomotive as a Factor in Mine Haulage, by F. C. Keighley, Supt. of Mines, Uniontown, Pa.

Cement Flumes.

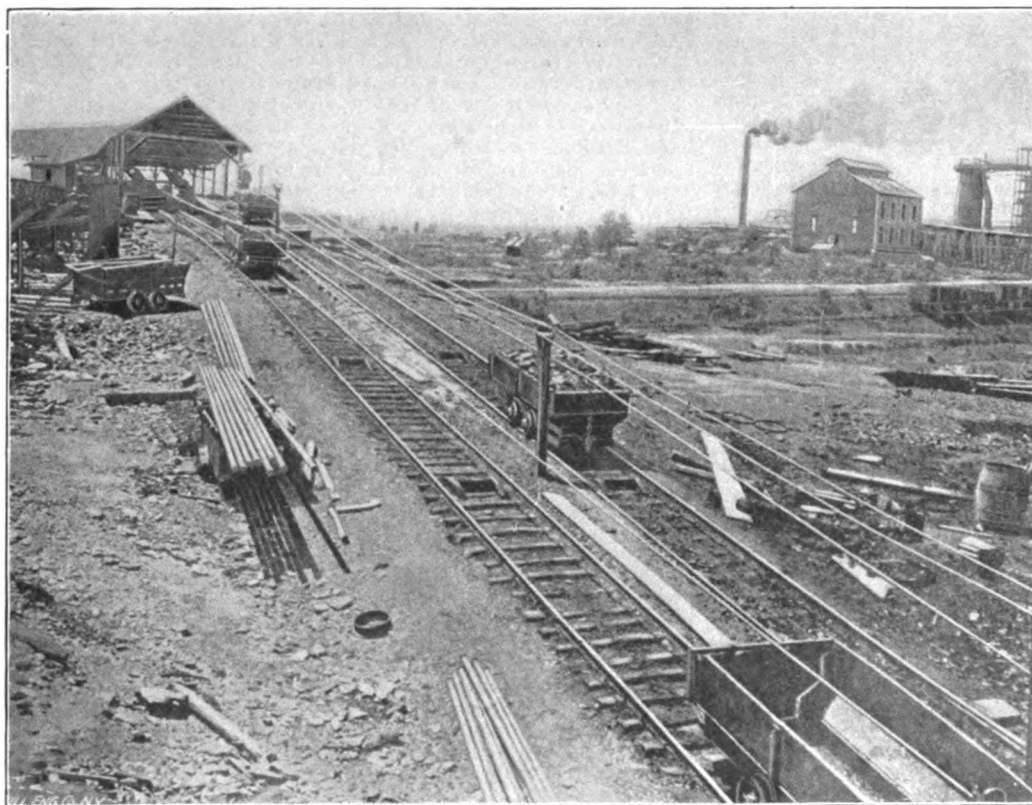
The cement flumes built by the Arroyo Flume & Ditch Company, Los Angeles, Cal., last spring have proved to be such a success that others will undoubtedly be constructed along the ditches of the company's system, which embraces a large acreage in the vicinity of Downey, California. The company spent about \$20,000 on the flumes built last spring. It is now proposed to spend \$10,000 in extending the flumes. In the cement flumes there has been practically no trouble from obstructions caused by weeds and other articles as in the dirt ditches, and the flow in the cement flumes is said to be even more rapid than in the wooden ones.—*Cement and Slate.*

ENDLESS ROPE HAULAGE

At the Pratt Mines of the Tennessee Coal, Iron and Railroad Company at Ensley, Alabama.*

The following is a description of a new system of endless rope haulage installed at the new slope No. 3 Pratt coal mine of the Tennessee Coal, Iron & Railroad Co. at Ensley, Alabama. It was designed and its details worked out by Erskine Ramsay, chief engineer of the company, whose early experience in coal mining and coke making was in the Connellsville region of Pennsylvania. The plant in question was put in to replace the old arrangements at plants at Slope No. 3, which at the outset were intended to exhaust this particular part of the coal field. The economies possible under the new system are such that the decision to make the expenditure for its installation was readily made.

The Pratt seam is the principal seam in the Warrior coal field, being practically coincident with it and lying near the top of the coal measures. It is underlaid by other well-known seams, as the Double, the New Castle and the Blue Creek. The mines are mostly opened upon the outcrop of the seam, following it down



ENDLESS ROPE HAULAGE, PRATT MINES, ENSLEY, ALA.

on the pitch, which is from 15 to 25 per cent., to the basin or more level part of the seam, this being from 1,000 to 2,000 feet from the outcrop. The Warrior coal field has been the backbone of the Birmingham district since the demonstration of the fact that this coal would make a furnace coke second only to Connellsville, being at the same time a steam and domestic coal of excellent quality. The old opening was of the slope type, as is also the new, the slope being opened on the outcrop of the coal and following it down. The grade at the outcrop was about 15 degrees, which flattened considerably, and so much so that when the slope had reached a point about 1,200 feet from the outcrop the pitch was so reduced that the mine cars would no longer drop by gravity into the mines and pull the rope after them. This necessitated at this point the introduction of another engine to haul the coal from interior points in the mine to the foot of the slope, from which point it was hauled by the outside engine on to the tippie. This rehandling was expensive and besides kept the output of the mine down to a maximum of about 700 tons a day of nine hours' work.

Features of the New System.—As the field of coal is quite large it was determined to put in a new hoisting plant and use, instead of the old slope or engine plane system, the newer over-

head endless rope system, and with this object in view an opening was made at the outcrop about 100 feet west of the old opening and the direction was changed so as to put the new haulageway on about the line of the greatest dip of the coal seam. This new haulage road or slope ran through quite a portion of the old workings of the mine and intersected some of the existing haulage roads, but with the exception of 300 or 400 feet near the outcrop there was no great difficulty encountered in putting through the new haulage road. The new slope or haulage road was made double-track and laid with 40-lb. rails, and to begin with the inside terminus of the haulage was fixed at a point about 4,000 feet from the tippie, the idea being to extend the haulage from time to time as the workings of the mine advanced. The elevation of the bull wheel or return sheave in the mine is 313 feet above sea level and at the tippie it is 586 feet, the maximum grade being about 15 per cent. and located near the pit mouth.

The general arrangement of the engine driving the haulage machinery is shown in Fig. 2. This is an 18" X 42" single Corliss engine, and it is belted to the rope driving mechanism which is of much the same pattern and general design as the cable road appliances used in some cities. It will be noted that both drums are driven. The engine itself is connected in such a way as

to be thrown out of gear with a friction clutch, thus stopping the rope almost instantly when a signal is given from any point along the haulage road in the interior of the mine. These signals are given over a system of electric apparatus consisting of two wires strung along the entire length of the haulage road and separated about 8 inches, the signals being given from any point by pressing the wires together or connecting them by a "steel" which is carried ordinarily by the chainers who hook on the cars to the rope, and whenever the wires are connected the vibrating bell rings in the engine room. The batteries and other apparatus are located in the engine room. One wire of the signaling apparatus is utilized for telephone purposes, the phones being located in the engine room and at several points along the haulageway. This is done to furnish almost instantaneous communication between the outside and various points in the mine when from accident or other cause it becomes desirable.

The empty cars going in and the loaded cars coming out are attached singly or in pairs to the rope at intervals of from 100 to 200 feet, depending, of course, upon the amount of coal which it is required to haul.

The rope travels at the rate of 158 feet per minute and delivers to the tippie a constant stream of loaded cars which are dumped onto the screens or into the railroad cars as they are delivered from the rope.

Method of Attaching Cars to the Rope.—In the mine the cars are attached at the various landings or headings by simply raising the rope and allowing the cars to run underneath by gravity, the rope being guided into a V-shaped automatic clutch "grip" or "grab." The empties are taken off by simply raising the rope and placing it in a pulley fixed overhead in the roof, and as the cars come along, the rope gradually and automatically lifts out of the "grab," releasing the car, and it passes off the main line into the switches or side-tracks by gravity. The "grabs" or clutches are shown in detail in Fig. 3. These "grabs," as is shown, fit into two sockets on the rear end of the car, the motion of the rope and the friction of the same in the "grab" causing the latter to turn slightly sideways and firmly grip the rope, the tightness of the grip on the rope depending upon the grade of the track. The heavier the grade the firmer will the "grab" take hold of the rope. These "grabs" hang and are free to turn in the sockets in either direction, so that they either pull the car when going up grade or hold it back when going down grade.

When the cars reach the tippie they are automatically released

* Reprinted through the courtesy of The Iron Trade Review.

by a reversal of the grade, together with the gradual ascent of the rope to the sheave, which holds the rope in a fixed position. The cars then run by gravity to the dump and are returned to the empty track on the other side on a down grade, the rope being guided into the "grab" when the car starts off on another trip into the mine.

The rope when not carried by the cars runs on rollers placed in the center of the tracks for that purpose, but practically all of the time the rope is suspended by the cars at points of say 100 to 200 feet apart and does not sag enough to allow it to drag on the track or run on the rollers. This feature of the endless rope system described is different from that generally put in, as most mines carry the rope on rollers continuously, as it runs underneath the cars. This causes considerable wear and tear on the rope and renders necessary a constant renewal of the rollers. With the Pratt mine plant there is practically no wear on the rope except at either end of the haulage where it passes around, in one case the drums of the driving mechanism, or in the other case the bull wheel or sheave at the terminus of the haulage in the mine.

Advantages of Endless Rope Haulage.—The application of the endless rope haulage, such as the Tennessee company uses, to the hauling of coal in the mines is rather novel in this country, as is also the plan of hauling the coal direct from the interior of the mine at the various stations or landings along the haulage, up the slope and onto the tippie to be dumped from the mine cars ready for shipment. Some of the advantages of the system may be thus summarized: (a) Continuous and steady output of coal regardless of length of haulage. (b) Minimum engine power and steam consumption. (c) The long life of the cars and rope. (d) Minimum risk of accident to life and property. (e) Low cost of operation. The output of the present plant at Slope No. 3 is 1,200 tons, as compared with 700 tons by the old.

This same system of rope haulage is now in use by the

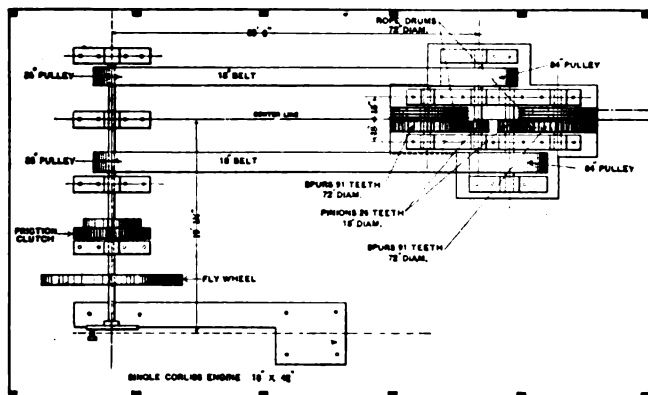


FIG. 2.

Tennessee Coal, Iron & Railroad Co. for delivering coal to the railroad tipples at Slopes Nos. 6 and 7, and is in course of installation at Slope No. 10 at Pratt mines. It is altogether certain that this particular haulage at slope No. 3 which we have described will be extended three or four miles, and while the main haulage will continue to be on a tangent it is possible, and is now a practice in some of the company's mines, to run a loop from the same rope into the side headings where they are very long and the haulage is expensive.

A prime feature of this plan of hauling coal as compared with the ordinary endless rope, or the more prevalent tail rope system, in both of which the cars are hauled in trips, is that no matter how long the haulage is, the capacity to deliver coal at the tippie is in no manner reduced. The coal will be delivered there just as fast as it is attached to the rope at the various stations, but of course the longer the haulage is, with a given distance between the cars the greater will be the total number of cars attached to the rope at any one time.

The life of the cars and rope is very much increased by this system. All of the moving parts run so slowly as to reduce to the minimum the usual wear and tear, which on long haulages of the usual type hauling in trips where high speeds are necessary to obtain the output, is quite excessive. Further, everything moves so slowly there is practically no danger of the cars overtaking a man who might happen to be traveling on the track. This system is capable of hauling over grades which would preclude the use of electric motors, and where the haul is quite long, as is the case in some of the Alabama mines, a great number of motors would be required and it would be necessary to run at high rates of speed to obtain the required output. No men ride with the cars as they are being hauled out and in, as is usual

where rope riders are employed, the only labor required being that necessary to attach the empty car as it is sent into the mines and the loaded car as it starts out. The cars take care of themselves while on the journey, which at Slope No. 3 requires about half an hour from mine to tippie.

Referring to Fig. 2, which shows the arrangement of engine and drums, the following details will be interesting, in addition to

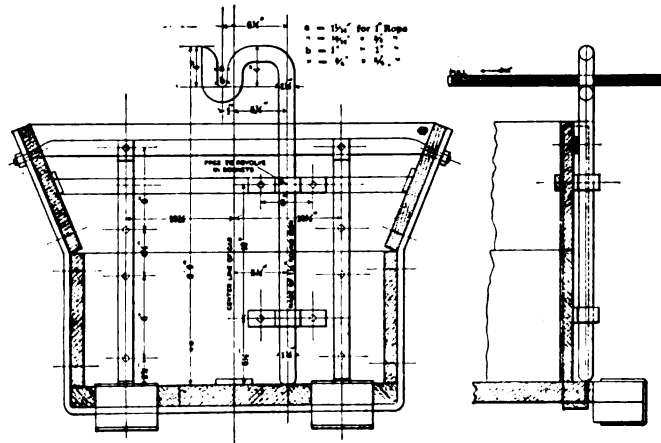


FIG. 3.

those given above: The diameters of the 20-inch pulleys are 3 feet and 7 feet for the engine shaft and pinion shaft respectively. The rope drums are 72 inches diameter, the spur gear wheel 72 inches and the pinion 18 inches. The initial steam pressure is 80 pounds and the mean effective steam pressure when the engine is working under load, 19 pounds; corresponding cut off, about 11 per cent.; revolutions of engine per minute, 68. The average horsepower developed, as shown by indicator cards, with the engine working under load is 69½. The rope, which is of 1-inch diameter, has a speed of 158 feet a minute. The average weight of empty mine cars is 1,276 pounds, and of the coal in loaded mine cars, 3,000 pounds, making the total weight of loaded mine cars, 4,476 pounds.

The Lunkenheimer Automatic Injector.

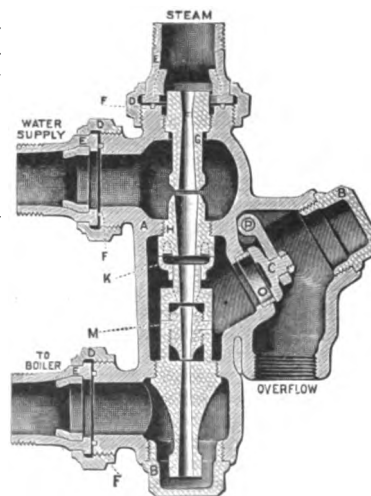
The illustration here given shows a sectional view of an automatic injector made by the well known firm, The Lunkenheimer Company, of Cincinnati, Ohio, and Denver, Colo. This injector is said to be absolutely automatic at all times, so that it can be relied upon to restart instantly after a temporary interruption of either the steam or water supply.

The exterior of the injector is heavily enameled giving it a very pleasing appearance, and all parts of the apparatus are well proportioned and made with due regard to durability. The body is of cast iron, and the tubes of a specially hard bronze composition made expressly for the purpose. The internal areas of these tubes are smaller than some other forms of injector of equal capacity; hence they will not wear out so quickly, but all tubes and wearing parts can be easily renewed at slight expense if worn. The tubes are all screwed into place and do not depend upon tight unions to secure them.

The Lunkenheimer Company issues a circular fully descriptive of this injector which explains in detail the method of setting it up, and would be pleased to send it to any interested party.

Sale of Claims.

The Government at Ottawa, it is reported, will offer for sale at public auction in Dawson every claim that has reverted to it by lapse or otherwise, and thirty days thereafter all claims not sold will be declared open for location.



FARNCOMB HILL GOLD DEPOSITS.

A Description of the Rich and Peculiar Deposits and Methods of Working Them Near Breckenridge, Colorado.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The gold deposits of Farncomb Hill, near Breckenridge, Colorado, are amongst the most remarkable in the West. The hill has long been celebrated for the beautiful specimens of flagré crystallized gold that have found their way into many museums in the country. Some millions in gold have also been extracted during a period of many years from this hill and its surroundings. The hill lies about five miles east of Breckenridge up French Gulch, celebrated in past years for its extensive placer deposits. All the way up the Gulch on the south side we see evidences of the extensive mining that took place in the "fifties," and is still being carried on. The banks of yellow gravel upwards of 100 feet deep are profusely channeled on the south bank by old and primitive sluicings which are being succeeded now by the newest and latest methods of hydraulic mining. These glacial placer deposits cover a large area and have a considerable thickness on the flanks of Mt. Baldy and Mt. Guyot. On the opposite or north side are several mines, such as the "Oro," which in silver days were good producers of lead and silver. There was quite a village at one time at what is known now as Lincoln.

The formations on the north side appear to differ from those on the south, being mainly sandstones of Cretaceous and Mesozoic age, metamorphosed into quartzites, and traversed by numerous dykes of porphyrite containing large crystals of orthoclase feldspar.

Just beyond French Flat and the Lincoln Mine the strata alter and become of great thickness, including several thousands of feet of black Marine Cretaceous shales, traversed by a few dykes of porphyrite. This is the formation which constitutes Farncomb Hill and in numerous minute veins or veinlets in these shales the celebrated specimens of gold ore have been found.

We ascend the hill by a steep well-graded road cut in the shales, and at the top find the Ontario Mine where a great deal of gold has been extracted from pockets and veinlets in the shale. Descending the opposite slope of the hill for some 600 feet we find the steep hillside of black shale penetrated by the numerous tunnels of the Wapiti Mine.

The principal veins on which these tunnels are located lie in the shale, with dykes of porphyry a few yards on either side. The dip of the shale is about 25 degrees and to the northeast nearly the whole black face of the hill has been scored by hydraulicking. Near the summit a flume runs for thirteen miles on a high line towards its source in the distant hills near Montezuma and Swandyke in the Continental Divide. From this flume, pipes with nozzles attached descend into the valley below, carrying water with enormous power and over 300 feet of head. At the bottom of the hill is a placer of considerable extent, the material having been derived from the detritus of Farncomb Hill.

Wherever prospecting has been done along the hill it has been by letting out sluice-water at intervals from the high line ditch and by booming, i. e., cutting a swath by a sudden rush of water down the mountain side through the loose detritus to bed rock shale. Two modes of mining have also been extensively followed, one that of mining by tunnels on the vein and across them, the length of these tunnels now aggregating about five miles, the other by booming and washing the surface and by hydraulic placer mining. The veins or veinlets containing the gold run in a series of minute cracks or cleavage planes, cutting the mountain from northeast to southwest. These steep fissures are also traversed by a flatter transverse set from southeast to northwest. The latter set are not so gold-bearing as the former, but rich pockets of ore are occasionally met at the point where the two intersect. The fine seams or fissures often contain a talcose soft substance very rich in gold, and calcite also occurs. At other places the vein consists of a narrow veinlet not more than half an inch wide of copper pyrite and iron, also carrying gold. The commoner occurrence is to find the fine knife-blade seam lined with fine gold, sometimes for several feet, as if it had been plastered or frescoed on the slate wall. The gold occurs in fine wires and in broad crystalline flakes and scales often of great beauty. Lead often occurs in the veinlets entwined with gold wire. All the gold is free milling, even that in the bodies of copper pyrite and iron. The free gold is carefully scraped off the walls. When contained in the pyrite gouge or wall rock it is treated with a Huntington mill.

There are a great number of veinlets scattered through the formation. In a width of upwards of half a mile of shale worked, as many as 50 veins are well known and others are doubtless as yet undiscovered. The veinlets are so small, often no thicker than a knife-blade, and so pockety is the ore, that it takes an experienced man to follow them into the hill. Occasional rich

pockets of ore have been found enclosed in the porphyry itself. A single pocket has often yielded many thousands of dollars of ore obtained in a few hours or days. One pocket alone yielded \$29,000 in a very short time. A certain "talcose" seam has also been a great yielder.

Quite as much work has been done on the outside of the hill by fluming, booming and hydraulicking and perhaps nearly as much wealth obtained as by mining by tunnels inside the hill. These outside surface values are found by washing the hill-side detritus and are mainly derived from the "overflow" or outcrops of the veins. Rich pannings are found where these outcrops occur, while a few yards on either side of them the ground may be barren. It is a difficult ground to prospect because the indications of such minute veinlets on the surface are rarely visible, almost all has to be done by a careful system of panning and subsequent booming or hydraulicking, a vein found can then be followed down with some degree of certainty. The mountain has been penetrated over 1,000 feet by tunnels which have a vertical depth of 300 feet. The gold found in the so-called placer below is like that found in the vein, viz.: crystalline in form, as if but little removed from its source, while that found in neighboring gulches coming down the other branches of the Swan River from Swandyke and Montezuma is water worn. At the confluence of these ravines in a little park there was in the days of "59" a camp of over 2,000 men, called "Parkville," and a great deal of rich placer gold and many large gold nuggets were obtained. In sluicing and hydraulicking over that section recently silver two-cent pieces of 1850 date are found, together with numerous Indian arrow-heads. The place was at one time defended by a stockade against the Indians. Into this park drains the waters of the new gold camp of Swandyke. In hydraulicking this slaty detritus in the placers, a steep grade and rapid and continuous flow of water are needed on account of the flatness of the slates tending to clog. A grade of from 8 to 10 inches is used, the sluices being 2 feet wide with block riffles.

The origin of this remarkable gold deposit is probably that suggested by the late Professor Eggleston, viz.: that the gold was either in solution or vaporized or sublimated condition when it ascended through these minute lines of least resistance and was precipitated and crystallized upon the walls of the fissures. The heat agencies were doubtless connected with the eruption of the dikes of porphyrite penetrating the hill, and quite rich deposits of gold have been found in the porphyrites, implying indirectly the source of the metal.

As the upturned and partially metamorphosed Cretaceous shales, traversed by identically the same porphyrite rocks as at Farncomb hill, are quite a characteristic feature of the Breckenridge region we see no reason why similar deposits of gold under similar conditions might not be found in that district by judicious prospecting and booming.

India Rubber.

More than a hundred million dollars' worth of india rubber has been imported into the United States during the past four years, and more than sixty million dollars' worth in the last two years. A decade ago the annual importations of india rubber amounted to about \$15,000,000; now they exceed \$30,000,000, and are steadily increasing. Practically all of the importations of rubber come in crude form for use of manufacturers, who are constantly extending its application to various new lines of industry. Northern Brazil, Southern Mexico, the West Indies, Central Africa, India, the Straits Settlements, and the Dutch East Indies supply this increasingly important feature of our importations. Probably no single article has made a more rapid growth in its relations to manufactures, and consequently commerce, in the past few years than rubber. As a consequence attention is now being given to the cultivation and systematic production of the various plants and trees from which it can be produced.

India rubber is not, as is generally supposed, the product of a single tree, but on the contrary is produced from a variety of trees and plants. Some of these flourish only in a moist soil and atmosphere, while others thrive on stony soil, provided they receive ample though intermittent rainfall; though in all cases a tropical or subtropical climate is requisite. Most of the india rubber of South and Central America and India is from trees, but in the islands of the Indian archipelago, the supply of rubber is chiefly from a gigantic creeper, which in five years' growth attains a length of 200 feet and from 20 to 30 inches in circumference, and which yields annually from 50 to 60 pounds of caoutchouc. Java, Sumatra, Penang, Singapore, and French Indo China are already large producers of crude india rubber, or caoutchouc, and its production in the West Indies has been sufficient to indicate the entire practicability of its being made an important industry in Cuba and Porto Rico, as well as in the Hawaiian, Philippine and Samoan Islands.

TRADE NOTICES.

The Bullock Mfg. Co., of Chicago Ill., has received a gold medal at the Paris Exposition for its diamond drills.

The Macomber & Whyte Rope Company, Chicago, Ill., has issued a very neat pictorial business card advertising its wire rope and other specialties.

The Bethlehem Steel Co., of South Bethlehem, Pa., has again opened an office in St. Louis at 930 N. Main St. in charge of Mr. S. E. Freeman.

The Bethlehem Steel Company, of South Bethlehem Pa., has appointed the Abner Doble Company, Fremont and Howard Streets, San Francisco, its agents for the Pacific Coast.

The 6 H. P. Mietz & Weiss gas engine and 4 H. P. direct connected kerosene engine and electric generator has been awarded the Silver Medal at the Paris Exposition, 1900.

The American Tin Plate Co., of Chicago, Ill., has repeatedly duplicated its orders for Cross oil filters and is now using 19 filters in its plant, which speaks well for the popularity of the Cross filter.

"Bethlehem" forgings have again scored in the remarkable results attained in the trial trips of U. S. battleship Wisconsin and Russian Cruiser Variag. The Wisconsin's shafts were forged from fluid-compressed nickel-steel, and those for the Variag from fluid-compressed carbon steel, all being shaped under the hydraulic press, carefully annealed, and finished according to standard practice.

Mr. Jos. H. Williamson, who for nearly eighteen years has been the business manager of the Manufacturers Advertising Agency, New York City, has severed his relationship with that company to connect himself with the old established Viennet Advertising Agency, 524 Walnut Street, Philadelphia, as its business manager in the place of Mr. Thompson, resigned.

The Link-Belt Engineering Co., of Nicetown, Philadelphia, has found its steadily increasing business requires the opening of an office at Pittsburg. It has accordingly opened one at 1501-2 Park Building, with Mr. T. Frank Webster, Link-Belt Engineer, in charge. Mr. Webster will have the care of all business in that vicinity for this company.

The Listie Mining & Mfg. Co., of Somerset, Pa., have installed an Ottumwa box car loader at their mines. This insures them increased business from parties who want their coal loaded in box cars, as it is claimed for this loader that it does not break and smash the coal, as is done when box cars are loaded by hand. It is claimed the machine has a capacity of 125 tons per hour.

In the second hand department of this issue, J. S. Mundy, Newark, N. J., manufacturer of hoisting engines, advertises a hoisting engine which ought to be of interest to any mine owner who wants a first class article at a very low price. The engine was shipped through an error, and was used only about two weeks, and returned to the manufacturer. It has been all cleaned up, and is in as good condition as when new, and thoroughly guaranteed.

The Bignall & Keeler Mfg. Co., Edwardsville, Ill., manufacturers of Peerless and Duplex Pipe Threading and Cutting Machines, report an excellent run of business. Among recent sales of their specialty are those made to the Tri-Mountain Mining Co., Houghton, Mich.; Aermotor Co., Chicago, (6); Mark Mfg. Co., Chicago; P. C. C. & St. L. Ry. Co.; Pullman Car Co.; United States Naval Academy, Annapolis, (one Duplex 16 in. machine with electric motor direct connected); Ohio Hospital for Epileptics, Gallipolis.

One of the most wonderful growths in the mining supply business has been achieved by the S. H. Supply Co., of Denver, Colo. In two years they have built a business to a point where they have no competition in their lines. New material is sold by them at less than the wholesale prices and second hand goods are valued entirely as to their conditions. They conceived the idea of buying complete plants, dismantling them, placing their material in first class condition, where it will be guaranteed to do the service claimed for it. In addition to this their purchases from sheriff's sales of new goods keep their stock to a point where in amounts it is not equalled by any house in Colorado. It will certainly be of advantage to get their latest catalogue, which is issued every two months, and fully describes the stock they carry.

The Ludlow-Saylor Wire Company, of St. Louis, is rapidly equipping itself to take care of a large amount of new business.

The company is about completing new factory buildings upon a site having a frontage of 200 feet on the Wabash Railroad, and a depth of 500 feet. The main building is 200 by 75 feet, and to this will be added later an L wing 225 by 75 feet. The building is heated by exhaust steam, and the water supply comes from a deep well, thus rendering the plant independent of the city water supply. Of the basement or first floor of the main building 75 x 150 feet will be devoted entirely to machinery for the manufacture of "perfect" double crimped mining cloth. These machines will be disposed in groups of three, each group to be driven by a 15 horsepower motor. The second floor is at present devoted to warehouse use, an extensive stock of wire fencing, barbed wire, plain wire, wire nails, etc., being carried. On the third floor there are now in operation power looms for the weaving of evaporator cloth, mill screen and the finer grades of mining cloth.

We have received the following communication from the Jackson Drill and Manufacturing Company, 756 Larimer street, Denver, Colorado, U. S. A.

DENVER, COLO., Nov. 8, 1900.

Mines and Minerals, Scranton, Pa.:

DEAR SIR:—All persons are notified that the Agreement of License from the Jackson Drill and Manufacturing Company, Denver, Colo., U. S. A., sole owners, for the manufacture and sale of the Jackson Hand Power Rock Drill, in Eastern United States and foreign countries, heretofore held by the Thornton N. Motley Co. (inc.), 48 John street, New York City, is terminated.

All persons are cautioned not to manufacture these drills; nor to purchase them, excepting directly from us or our authorized agents.

All unauthorized manufacture, sale or use will be promptly prosecuted.

THE JACKSON DRILL AND MANUFACTURING CO.,
by J. J. Crippen, V.-Pres't.

The Frank S. De Ronde Co., 52-54 John St., New York, with Branch Office and Warehouse at 48 N. 4th St., Philadelphia, calls special attention to its Federal Boiler Compound and De Ronde's Belt Dressing, both of these products having met with great favor wherever introduced, and especially throughout Pennsylvania in the mining districts. The company offers to send good sized practical working samples of these goods free of charge, or to ship these goods out subject to approval, to any responsible concern. It would pay all those interested to write direct to the company and procure samples of these products. The Frank S. De Ronde Co. is also general distributing agent throughout Pennsylvania for the well known P. & B. Ruberoid Roofing and all other P. & B. products, carrying a full stock of same at the Philadelphia warehouse, from where it is prepared to make prompt shipments. Ruberoid is now and has for many years, been in general use in and about mines, for roofing, covering pipes and hosts of other purposes. This roofing is absolutely water, acid and alkali proof, free from tar and asphalt, strong and very durable. It is also in extensive use by almost every large steam railroad in the country. Those who have not received the large sample books of Ruberoid Roofing should send for copy of same, which will be gladly furnished on application.

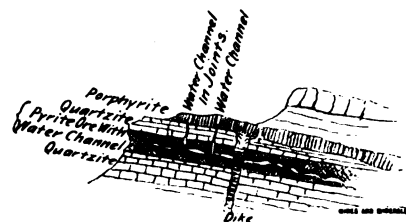
The steam plants in the State of Ohio are being rapidly equipped with low water alarms in conformity with a recent enactment of the Legislature of that State. A large number of these devices sprang up to take advantage of the requirement, but it was soon demonstrated that the majority of the manufacturers, recognizing the wisdom of placing the safety of their plants in the keeping of devices that have been tested and not found wanting, would only consider bona fide safety water columns of recognized merit and proven ability. The extreme simplicity of the Pittsburgh Safety Water Column, manufactured by the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., combined with its absolute reliability under any and all conditions to which it may be subjected, easily made it a favorite with steam users who wished to throw about their plants the mantle of protection, that can be relied upon first, last, and all the time. The Pittsburgh Gage & Supply Company planned and executed a brilliant and energetic campaign in Ohio in behalf of their safety water column, which has proved eminently successful. The company had such implicit faith in the superiority of the Pittsburgh Column as a safety and saving device, and that this superiority would be recognized by steam users when brought to their attention, that early in the season the factory was put in operation day and night, and the result of this well planned and executed campaign shows the wisdom of their action. The surplus stock thus accumulated has enabled the flood of orders to be taken care of with reasonable promptness, and already some 1,500 Pittsburgh Safety Water Columns have been installed in Ohio alone, comprising hundreds of prominent concerns ordering a large number of columns each, among which are the following: American Sheet Steel Co., 95; American Steel & Wire Co., 72; Lake Shore & Mich. So. Ry., 80; American Steel Hoop Co., 61; Crown Fire Clay Co., 24; Structural Steel & Iron Works, 20; Ohio Steel Co., 20; Fleischman Company, 12; Erhart & Company, 12; Cincinnati Water Works, 12; Youngstown Steel Co., 10; Hoover & Allison Co., 10.

All this was derived from oxidization of the original massive pyrite. The deposit lay between a greenish quartzite and an overlying sheet of intrusive red syenite consisting of red orthoclase feldspar sprinkled with black crystals of hornblende. A few assays taken of both the pyrite and iron oxide showed the values to be too low grade for profit.

As a practical suggestion to a prospector or miner who may come across such kinds of deposits we may offer the following considerations, which occurred to us at the time:

First.—What shall we do with the massive pyrite? What treatment is it adapted to? Clearly it is not a concentrating

proposition, because it is already concentrated and there is no quartz or gangue matter with it. It is a solid mass of uniform mineral. It is a case of either smelting, or cyaniding, or chlorination. Therefore it must either be shipped to a smelter, or a cyanide mill must be established at the foot of the mountain. The ordi-



MODE OF FORMATION, OXIDATION, AND ENRICHMENT OF MANCOS AND SIMILAR CONTACTS.

nary stamp and concentrating plant already located there could do nothing for such ore. Pyritic smelting by the Austin process would be also unavailable, because of the absence of copper in the deposit, and in the immediate vicinity. Silica, essential to this process, could be, it is true, mechanically supplied although absent in this pyrite deposit. The pyrite ore, supposing it to have sufficient value, is a clear case of ordinary smelting (i. e., apart from the other processes).

Then the question comes—is there value enough to pay for shipping and treatment from this locality?

The oxidized ores on the other hand, provided they carry sufficient values, are presumably free milling ores and could be treated perhaps at the mill 2,000 ft. below, down the steep mountain.

The question of values will have to be determined by assay and mill run and by far deeper development than a 10 ft. prospect hole before such works as a necessary 4,000 ft. long, bucket-tramway be erected down to the present mill. Such a tramway would be a necessity, because a large low grade proposition at this great height would infallibly have to be operated in this way and on a large scale to succeed.

We examined another deposit at a lower level, and more accessible to the mill. Here a big brown oxidized outcrop, about 8 ft. thick, appeared on the side of the cliff close to a dyke of diorite. In this case a hole some 8 or 10 ft. deep showed the thickness of the whole outcrop, for that depth, to be well oxidized and entirely honeycombed, with comparatively little pyrite showing. Mingled with this oxidized gossan was a good deal of bright micaceous iron ore, or specular iron in flakes, a secondary product after oxidization and metamorphism. Even this well oxidized mass gave very disappointing assays, but might prove better with greater depth, as at Mancos.

A third deposit was of a somewhat different character from the others. In this case there was no sedimentary rock present, but a thick horizontal sheet of intrusive diorite had, for a considerable distance, been impregnated by mineral solutions presenting the appearance of a large brown rusty bank, cut by a narrow canyon, down which descended a waterfall from the snow-fed amphitheatre in the mountains above.

This big brown patch early attracted the prospector's attention and on the strength of its possible values, a large mill was erected close to it with abundant water power to run it. An open cut, made for some distance through this brown mass, showed the volcanic rock to be in layers which dipped upwards into the hill. This inclination we believe was caused by the bending downward tendency of rocks on the steep slope of the hill, a not uncommon occurrence with rocks outcropping on steep hill sides. The cut showed that the rocks were here and there spattered with small irregular patches of pyrite, too irregularly scattered, as a rule, to concentrate, except on a very large scale. Assays unfortunately showed this pyrite to be very low grade. Better values were found in the brown oxide, but this proved to be only a thin coating of the layers of porphyry and disappeared entirely at a few feet in depth.

In one portion, however, of this deposit was a shearage zone or possibly a dyke, which was especially oxidized and was traceable, by its brown rusty color, for a few hundred feet across the waterfall ravine. Values in this were fairly good, but a tunnel run in about 50 ft. below it found this zone or dyke, with its parallel vertical shearage planes, to pass into hard diorite, barren, except for a narrow streak of iron pyrite, which, as before, proved valueless. What values there were, were in the oxidized material

only, and this was proved to be only superficial and not enough of it to keep a large mill going for any length of time.

We have been particular with these instances because similar propositions may often occur to the miner, prospector, mine speculator or mine buyer, and it may make a man look before he leaps, and see the various considerations that may be in the way of what at first sight may appear to be a very likely and attractive property.

In a subsequent article we shall give a description of some other cave deposits and peculiar mines.

Phosphate Rock.

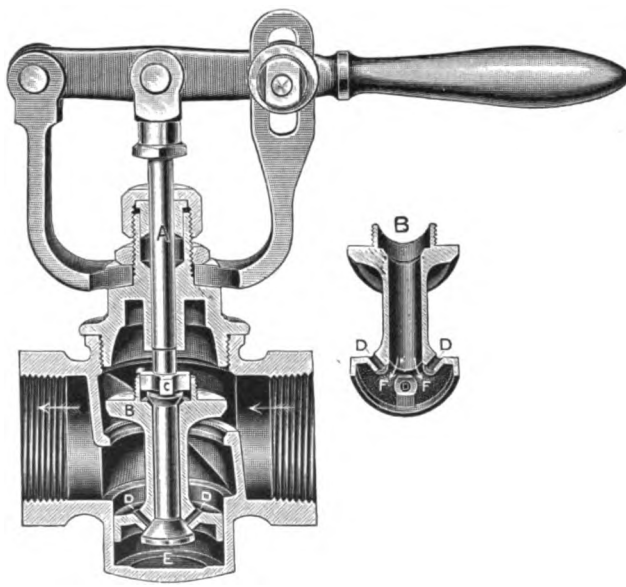
The phosphate-rock industry in 1899 was marked by considerable increases in production in Florida and Tennessee, decreased production in South Carolina, a notable advance in the values of Tennessee rock, and the beginning of a phosphate-mining industry in Pennsylvania. In Florida the increase in production was shared by the miners of hard rock, land pebble, and river pebble. No production of soft rock was reported in either 1898 or 1899. The decrease in South Carolina was in the production of land rock, which fell off nearly 75,000 tons, and was only partly made up by an increase of over 30,000 tons in the production of river rock. Tennessee's production increased 37½ per cent. Pennsylvania entered the phosphate industry with an output of 2,000 tons.

A New Throttle Valve.

The Pendry balanced throttle valve, shown in section in the accompanying cut, is particularly well adapted for use on hoisting engines, marine engines, steam shovels, and on all quick-acting engines, as by means of it the full boiler pressure can be instantly admitted to the cylinders and as instantly shut off. In addition to its quick opening feature it is also a perfectly balanced valve, and so can be very easily operated no matter how great the steam pressure being used.

Its operation is as follows: The stem *A* forms two seats with the main valve *B*, one at its upper and one at its lower end. The first slight movement of the handle will raise the stem *A* off its upper seat. The steam passes in through this opening, down through the body of the valve *B* in the space around the stem, and into the balancing chamber *E* through the openings marked *F* on the small sectional view of the valve body to the right. In this way the full boiler pressure is admitted into the chamber *E*, balancing the valve, and as the same pressure is below as above it, it is very easily operated.

It should also be remembered that while this valve is primarily a quick opening one, it can be opened as slowly and as



SECTIONAL VIEW.

gradually as a screw stem valve, and it will stay open at any point you may desire to set it. This feature makes it adapted for use on all types of steam engines. The question of leakage can also be prevented in this valve, as it has but one seat and this can be ground same as that of a globe valve. Circular giving full description may be had by addressing the manufacturers, The Detroit Lubricator Co., Detroit, Mich.

ELECTRIC LOCOMOTIVES.

Principles Which Determine the Size and Power of Locomotives Necessary for Various Loads and Grades.

Written for MINES AND MINERALS, by H. K. Myers, C. E.

Electric locomotives have proven more popular than compressed air, principally because they are more compact and can be used in thin seams without expensive enlargement of gangways.

The vital point in their use is in not overloading them for a long period of time. The motors as constructed at the present time by the best manufacturers are in reality a wonder—while they have a certain horsepower rating based in general on their ability to do given work continuously for 1 hour yet for very short periods this work may be increased 100%. While horsepower rating is universal, yet it is misleading and the proper way should be "draw bar pull" at given speeds.

At present we have the notation, say 25 horsepower, which means a variety of things. It may mean a small torque and high speed or vice versa.

In the development of mining locomotives it has been determined that the weight of any locomotive running at speed of 6 to 8 miles per hour with intermittent load should be on the basis of 400 lb. for each 1 horsepower of the rating of the motors and also the weight should be eight times the rated draw bar pull regardless of speed.

If the work is continuous, the above weights should be decreased 25%.

A certain part of the power of a locomotive must be used to haul itself and where the grades are heavy this amounts to considerable.

The following table, No. 4, gives the normal draw bar pull on various grades for several different sizes locomotives:

TABLE 4.—DRAWBAR PULLS ON GRADES.

H. P.	Weight.	Grades.						
		Level.	1%.	2%.	3%.	4%.	5%.	6%.
10	4,000	500	460	420	380	340	300	260
20	8,000	1,000	920	840	760	680	600	520
30	12,000	1,500	1,380	1,260	1,140	1,020	900	780
50	20,000	2,500	2,300	2,100	1,900	1,700	1,500	1,300
70	28,000	3,500	3,220	2,940	2,660	2,380	2,100	1,820
100	40,000	5,000	4,600	4,200	3,800	3,400	3,000	2,600

In mines it is found that the friction between wheel and rail is less than outside. This is due principally to the dampness and powdered coal on rail.

It is therefore considered that the running tractive effort with chilled wheels is one-eighth the weight.

The following table, No. 5, gives the hauling capacities of locomotives in tons of 2,000 lb. on various grades.

TABLE 5.—HAULING CAPACITIES OF LOCOMOTIVES ON VARIOUS GRADES, IN TONS OF 2,000 LBS.

H. P.	Weight.	Draw Bar Pull on Level.	Frictional Car Resistance per Ton on Level.	Grades.											
				Level.	1%	1½%	2%	2½%	3%	3½%	4%	5%	6%	7%	8%
10	4,000	500	20	23	15	10	8	6.3	5.2	4.2	3.5	2.2	1.6		
			30	15	11	8.4	6.7	5.4	4.5	3.8	3.2	2.0	1.5		
			40	12	9	7.0	5.7	4.7	4.0	3.4	3.0	1.8	1.4		
20	8,000	1,000	20	46	29	21	16	13.	10.3	8.4	7.1	6.0	4.3	3.1	
			30	31	22	17	18	11.	9.	7.5	6.4	5.4	4.0	3.0	
			40	23	18	14	11	9.5	8.	6.8	5.9	5.0	3.7	2.8	
30	12,000	1,500	20	69	44	32	24	19.	15	13	10.7	9.0	6.5	4.7	
			30	43	33	25	20	16.	13	11	9.6	8.2	6.0	4.4	
			40	34	26	21	17	14.	12	10	8.6	7.5	5.6	4.1	
50	20,000	2,500	20	115	73	52	40	32	26	21	18	15.	11.	7.9	
			30	77	55	42	33	27	22	19	16	14.	10.	7.8	
			40	58	44	35	29	24	20	17	15	13.	9.3	6.8	
70	28,000	3,500	20	161	103	74	56	44	36	30	25	21	15	11.	
			30	107	77	59	47	38	31	26	22	19	14	10.	
			40	81	61	50	40	33	28	24	20	18	13	9.6	
100	40,000	5,000	20	230	147	105	80	63	52	42	36	30	22	16.	
			30	153	110	84	67	54	45	38	32	27	20	15.	
			40	115	88	70	57	47	40	34	29	25	19	14.	

The numbers 20, 30 and 40 opposite each size locomotive is the different resistances per ton in cars due to friction.

If a short adverse grade is encountered, the indicated loads may be increased 50%.

When motors are given overloads they heat rapidly and this heating varies directly as the square of the current.

For this reason each motor should have a given ampere

rating for continuous work and from such rating, having the profile, it is possible to calculate the number of trips of given size any locomotive is capable of hauling in a given time.

Thus a motor which has a rating of 40 amperes for regular work if worked for 3 minutes at 100 amperes should not be subjected to such work oftener than $3 \times 100^2 = x \times 40^2$, $x = 18\frac{1}{2}$ min.

In order that this principle may be applied we will use the same problem as the one in which we calculated for air haulage, on page 189, November number of MINES AND MINERALS, which was as follows:

EXAMPLE.—It is desired to haul trips of 60 cars, empties weighing 2,000 lb. and loads 6,000 lb. each, over a track having the following profile, and with one charge of air. All grades are in favor of loads.

PROFILE OF ROAD.

Grade %.	Distance.	Grade %.	Distance.	Grade %.	Distance.
1.3	800 ft.	0.3	700 ft.	2.4	400 ft.
2.0	600 ft.	1.77	1,025 ft.	3.5	425 ft.
1.3	800 ft.	0.9	800 ft.	1.2	820 ft.

The maximum grade being 3.5 per cent., and the car friction in this case being 1 per cent., the total resistance when ascending a 3.5 per cent. grade due to cars is, hence, $3.5 + 1 = 4.5$ per cent. Since it is desired to haul 60-car trips, and all grades are in favor of loads, it is only necessary to provide a locomotive capable of hauling 60 empties weighing 120,000 lb. up the above-mentioned grade. The drawbar pull necessary to do this is 4.5 per cent. of 120,000 lb. = 5,400 lb. In general, it will require a locomotive having a weight on drivers of five times the tractive effort desired if steel tires are used, as is the practice in the construction of air locomotives, and 6 times the tractive effort if cast-iron chilled wheels are used, as is the practice in electric locomotives. We will, therefore, assume the necessary weight of the locomotive to give the proper adhesion as 32,000 lb., and we calculate that the tractive effort necessary to haul itself up the 3.5 per cent. grade would be $3.5 + .5 = 4$ per cent. (.5 per cent. covering the friction of the locomotive on the level) of 32,000 lb., or 1,280 lb., to which we add the necessary drawbar pull to haul the desired

Grade.	Dist.	T. E.	Time. Min.	Amps.	ta ² .
1.3	800	3,375	1.5	114	19,600
2.0	600	4,450	1.1	184	19,900
1.3	800	3,375	1.5	114	19,600
0.3	700	1,830	1.3	74	7,100
1.77	1,025	4,100	2.0	128	32,800
.90	300	2,750	.6	100	6,000
2.40	400	5,075	.8	148	17,300
3.50	425	6,760	.8	182	26,500
1.20	820	2,220	.6	86	4,400
.3	700	2,600	1.3	96	13,900 loads.

$$167,100 = \Sigma ta^2.$$

load, 1,280 + 5,400, and have a total tractive effort of 6,680, which is about the limit of our locomotive on dry rail with sand.

Our maximum tractive effort being 6,680 lb., by examining table 4, we see that the locomotive equipped with two 50 (equal 100) horsepower motors will carry the load with an overload. These

H. P.	Weight.	Draw Bar Pull on Level.	Frictional Car Resistance per Ton on Level.	Grades.											
				Level.	1%	1½%	2%	2½%	3%	3½%	4%	5%	6%	7%	8%
10	4,000	500	20	23	15	10	8	6.3	5.2	4.2	3.5	2.2	1.6		
			30	15	11	8.4	6.7	5.4	4.5	3.8	3.2	2.0	1.5		
			40	12	9	7.0	5.7	4.7	4.0	3.4	3.0	1.8	1.4		
20	8,000	1,000	20	46	29	21	16	13.	10.3	8.4	7.1	6.0	4.3	3.1	
			30	31	22	17	18	11.	9.	7.5	6.4	5.4	4.0	3.0	
			40	23	18	14	11	9.5	8.	6.8	5.9	5.0	3.7	2.8	
30	12,000	1,500	20	69	44	32	24	19.	15	13	10.7	9.0	6.5	4.7	
			30	43	33	25	20	16.	13	11	9.6	8.2	6.0	4.4	
			40	34	26	21	17	14.	12	10	8.6	7.5	5.6	4.1	
50	20,000	2,500	20	115	73	52	40	32	26	21	18	15.	11.	7.9	
			30	77	55	42	33	27	22	19	16	14.	10.	7.8	
			40	58	44	35	29	24	20	17	15	13.	9.3	6.8	
70	28,000	3,500	20	161	103	74	56	44	36	30	25	21	15	11.	
			30	107	77	59	47	38	31	26	22	19	14	10.	
			40	81	61	50	40	33	28	24	20	18	13	9.6	
100	40,000	5,000	20	230	147	105	80	63	52	42	36	30	22	16.	
			30	153	110	84	67	54	45	38	32	27	20	15.	
			40	115	88	70	57	47	40	34	29	25	19	14.	

motors are rated for continuous work at approximately 32 amperes at 500 volts and the curve sheet attached is the one from which we will get our data.

We have the formula for two motors as follows:

$$\sqrt{\frac{\Sigma ta^2}{T}} = 64;$$

in which t is the various times at which various amounts a of current are used on corresponding grades and T is the total time that should be taken for each trip. If made in less time, the difference would represent rest or running down grade without current.

$$\sqrt{\frac{167,100}{T}} = 64$$

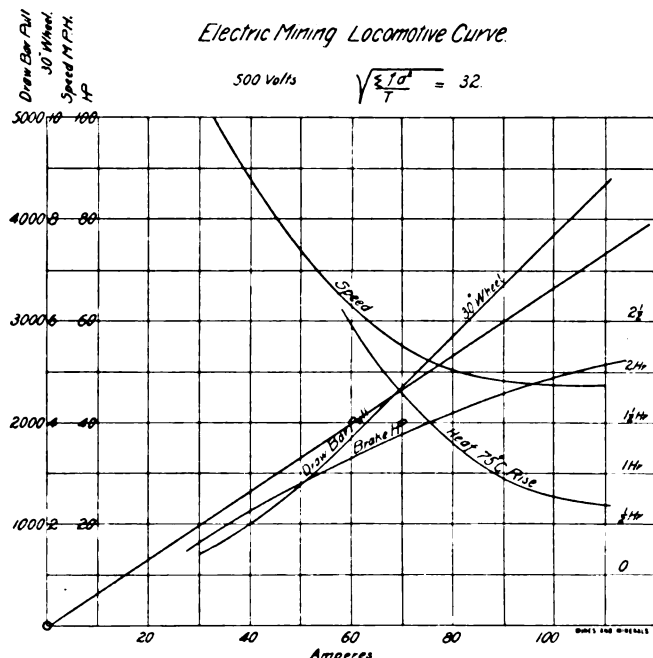
$$4,096 T = 167,100$$

$$T = 40.$$

This means that we can make 60 car trips every 40 minutes without injury to motors. It would be possible to make them oftener but to the detriment of the locomotive.

The time for making the various distances is based on a speed of 6 miles per hour.

The class of an electric locomotive is generally designated by using some of the component parts. Thus the Baldwin-Westinghouse notation $4\frac{1}{2}C$ means 4 wheels, two 50 horsepower motors and two pairs of drivers. C class $4\frac{1}{2}B$ means 4 wheels, one 50 horsepower motor on one axle. $4\frac{1}{2}C$ would mean 4 wheels and one 50 horsepower motor geared to both wheels. $6\frac{1}{2}D$ means 6 wheels with three 50 horsepower motors, one on each axle. The design is generally such as to suit existing conditions. In some mines the clearances are a minimum and the height a maximum, hence a narrow locomotive with considerable height—the gauge varies with local conditions and the ideas of the man in



charge. Many mineral mines have as narrow as 18" gauge. In the Clearfield coal region the prevailing gauge is 36", while in the Pocahontas region it is 44".

The wheels in general are cast chilled principally for the reason that the costs for renewals are less.

While the coefficient of friction between steel tires and rails is greater than between chilled wheels, and consequently greater tractive effort for former with same weight of locomotive, yet the cost of renewals is such as to prevent their use. In general it may be considered that steel tires produce about 20% greater tractive effort which to overcome with chilled wheels is accomplished by the addition of proportional weight.

The wheel base is a matter of vital importance and is governed by the radius of existing curves which is generally a minimum. By actual experience this is about 25 ft. for 3' gauge and 5' wheel base. It has become the practice to use 30" wheels for standard locomotives of 15,000 lb. and upwards. The life of the wheels varies with the conditions. In some mines where it is necessary to use considerable sand they cut out in 3 months, while in others they last 3 years. While it is not the universal custom yet in all cases the wheels should be pressed and keyed on axle. Unless they are keyed they will gradually loosen and cause considerable trouble.

The height is in general a minimum and should not be less than 4" more than top of wheels on account of the strength necessary in the frame immediately over the springs.

The width is entirely governed by the gauge. If it is such that the frame can be placed inside of wheels, then it is the

gauge plus the wheel treads. If too narrow for such construction we must add to the above the thickness of frames which cannot be less than the length of journals. Where the frames are necessarily light, in order to reduce weight, they are webbed. The winding of the motors is made to suit conditions but never more than 8 miles per hour, and in many cases only 6 miles.

This is the speed at full load but if the load is decreased the speed increases. It is customary to give the locomotive a weight of eight times the average draw bar pull, but in starting it is possible with sand to develop a draw bar pull equal to $\frac{1}{2}$ the weight; hence, in general, we may say that the starting draw bar pull is 60% more than that when running.

The windings of the motors are in all cases suitable for the line pressure, taking into consideration the line loss. Thus, for 250-275 volts at the generator the motors are wound for 220 volts. If the line loss is small then the speed of the locomotive is increased above the normal; and the reverse occurs when the voltage drops below that for which the motor was constructed. It has been found that the railway type of 4 poles are the ones best adapted for this service. They are practically waterproof and almost indestructible. The armatures are of the iron clad ventilated type with large air gap which allows for considerable wear on bearings.

The windings should be embedded below the surface and securely held in place so as not to allow them to in any way catch on the fields.

The commutators should be of hard drawn copper with mica insulations in order that there may be a maximum life to them. There should be ample provisions for access thereto in order to examine and adjust both the commutator and brushes.

Great care should be taken that the grease does not work through and saturate the insulation of the armature or fields and thus cause short circuits.

The gears should be of best cast steel and designed for maximum strains. In the darkness of the mines it is often necessary to reverse when going at full speed and thus throw a very heavy strain on the gears, which if not of ample dimensions are apt to break. It is the custom with some builders to have a brake wheel on the armature shaft and thus apply the brake with a minimum amount of power, but at great detriment to the gears and in the event of a gear breaking the locomotive is helpless.

The controller best adapted to this class of service is of the rheostatic type and should be so designed that when using the maximum amount of current the contact points will not heat to the danger point. It should also be provided with a blowout to prevent arcing.

One of the vital points is the diverter or rheostat. With the variable load as found in mines it is scarcely possible to run without resistance. Under such conditions much power is taken up, with the consequent heating and necessarily to the detriment of the diverters. There is no remedy for this but renewal. In general, they are columns or plates of iron and mica and offer given resistance to the current. They should be so placed as to get a large amount of air when the locomotive is in motion.

In connection herewith it might be well to call attention to the general track formula for determining length of lead rail, radius of curve, etc.

Lead rail equals twice the gauge times the number of frog, or $l = 2gn$. Radius of curve equals twice the gauge times the square of the number of frog $= 2gn^2$. From the above, if we have the length of the lead rail, we can readily ascertain the radius of the turnout curve.

The wiring should be so far as possible carried in a single cable along the side of the locomotive in a groove so as to give easy access to motors and protection to the cables. It should have heavy insulation and be very rigidly clamped to inner side of frame. It should be clear of all sharp corners and sufficiently far from rheostat so that in the event of excessive heat therein, it will not be injured thereby.

The trolley pole should be of a reversible type and so designed that it accommodates itself readily to maximum or minimum heights. The locomotive should be so constructed that the trolley pole can be placed on either side or end as the conditions require and in the general form of construction the center of the socket should be over the gauge line and on the ditch side so as to remove the element of danger as far as it is possible to do so.

The sand boxes should be fitted fore and aft with spouts for each wheel. The brake should be of such design as to be easily applied with one hand and when the motorman is in a cramped position. In general, some form of screw brake is considered most preferable.

Some purchasers prefer oil to electric headlights. The former are possibly more satisfactory since they furnish light always. It is no easy trick to replace trolley on wire midst the darkness of the mines.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *appears* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 608 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Basalts and Basaltic Lavas.

Basalts are lavas probably better known generally than the andesites. There are so many remarkable displays of them, such as Fingal's Cave, the Giant's Causeway, the Palisades of the Hudson, that have attracted the eye of even those who are not generally interested in rocks, principally by their peculiar symmetrical, columnar habit, that basalt has become historical. Doubtless in many cases any very dark looking lava, especially if it developed a columnar structure has been dubbed "basalt" though it often may have been some other form of volcanic rock. Another circumstance that brings it into notice is that modern volcanoes for the most part, are pouring forth basalt, and prodigious areas both in this Western America and in other parts of the world are covered by the flows of this lava poured forth from Tertiary times till the present. In a great number of cases, especially in the West when you see isolated table lands and "flat tops," they are usually either capped with sandstone or super-capped by basalt.

From a mining point of view for some unknown reason, common basalt is not nearly so productive a rock as andesite. As a rule few ore deposits of any importance have been found associated with basalt dikes or overflows, and very few important mineral deposits are found in the vicinity of modern basaltic volcanoes. At Cripple Creek, however, a variety known as nepheline basalt occurs in dikes cutting the overlying andesite breccia and is prolific in telluride gold-bearing ores.

All rocks of the basalt family are heavy, black, gray or brown, sometimes microcrystalline, i. e., the crystals are so small and fine-grained as scarcely to be visible, whilst others are porphyritic, the crystals of which they are formed being very distinct. The latter generally come under the name "dolerite," which means a stony, coarse-grained form of basalt, that probably cooled slower than the basalt, and so allowed greater scope for its crystalline elements to form and individualize. The component crystals are plagioclase feldspar, black augite, bottle green olivine and mag-

netite, and the ground mass is a finely crystalline aggregate of these and some dark glass.

Olivine is the first crystal to alter in the decay of basaltic rocks, it becomes a network of green serpentine veinlets, enclosing an unchanged nucleus.

Augite passes into that greenish substance called chlorite which gave the name of "greenstone" to the old basalts which were also called "diabases." Under "shearing stress" according to "Kemp" these old diabases may pass into hornblende schists and chlorite-schists, very different looking rocks from their massive parent. These hornblende rocks are called amphib-

olites, and just as andesitic breccias and tuffs accompany massive flows of andesite, so basaltic tuffs and breccias may accompany massive basaltic flows marking an explosive stage in the eruption before the molten lava poured quietly forth. Hence we should expect alternations of breccia and massive beds of lava.

The oldest strata as well as the newest are penetrated by basaltic dikes both of the ancient diabase and the more modern basalt. The New England coast is seamed by them. In the East the intruded sheets of Triassic diabase form Mts. Tom and Holyoke (Mass.) and the Palisades of the Hudson, and are present in the iron and copper region of Lake Superior. The great basaltic areas are in the Snake River region of Southern Idaho, Oregon, and Washington. The lavas of Etna and Vesuvius are basaltic, and in India are the great basalt fields of the Deccan. All along the Eastern flank of the Rocky Mountains in Colorado, from north to south are numerous table lands, capped with basalt, and numerous "lone buttes" formed by dikes, or fragments of the sheet, spared by erosion.

A description of one of these mountains or table lands at Golden City, Colorado, may prove an instructive example of this class of rocks, of their common appearance in the field and their mode of occurrence.

Table Mountain, or rather the Table Mountains, for there are

two of them, a North and a South Table separated by the cañon of Clear Creek, are among the first striking features met on the way from Denver to the mountain region. As we look toward the range from Denver 12 miles west we notice at its base, a flat-topped bench, rising about 800 feet above the prairie, capped with a vertical wall about 100 to 200 feet. Seen from a distance there is a gradual slope of this table land from north to south. At the north end the lava wall or cap is thickest, and gradually

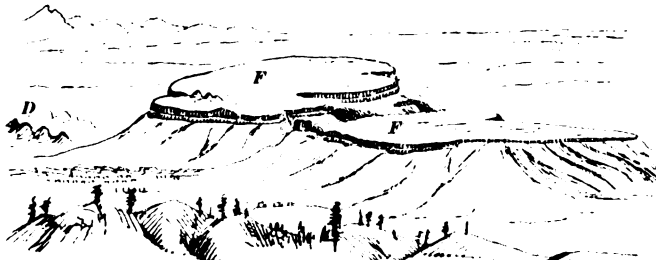
diminishes towards the south, suggesting that the source of the lava sheet was to the north, and that it thinned in its flow southwards. About a mile to the north are a series of sharp conical hills with little vertical walls of basalt on top, and beyond them a long hill with steep sides near Ralston Creek, also created by a wall of basalt. This is evidently the dike marking the fissure, or source of the lava from which it was extruded, and from which it poured southward over the then gentle southerly sloping surface of the country. At Ralston Creek the river has cut through the dike exposing it as a black wall on each side of the canyon, passing up through a once wide fissure in Cretaceous clays and shales. At the contact of the dike and for a distance of many yards on either side, the clays and shales are baked hard, sometimes into a jaspery hornstone substance, at others into the consistency of a brick.

Originally, doubtless, there was a flat-topped table land capping this dike, but this has all been eroded away, and we do not reach the flow portion for a mile or more from its source in the dike, in the North Table Mountain. The slopes leading up to these vertical dike walls are generally very steep compared to those composed of sandstone and other rocks.

Proceeding next to the table-lands, the flanks of these for nearly 800 feet are profusely covered with blocks of basalt fallen from the vertical terraced wall above, but the main body of the hill is composed of what appears at first sight to be horizontally stratified beds of coarse conglomerate, sandstone and shale, containing fragments of petrified wood and beautiful impressions of fossil leaves of a semitropical character. These sandstones and shales, are composed of comminuted fragments of lava and cindery lava or scoria, but of a slightly different variety from the heavy, black basalt wall capping the mountain. These fragments are of a lilac, or purplish or light gray or maroon tint, and are profusely spotted with little white crystals of feldspar which the basalt is not. Mixed with these are also little, longish black crystals of hornblende, whilst the black crystals in the basalt are augite. We recognize these fragments to be andesite and draw the conclusion that prior to the final flow of basalt capping the hill, there must have been vast eruptions of andesite from explosive



BASALT MAGNIFIED.
Showing Large Central Crystal of Olivine Passing into Green Veins of Serpentine Crossing the Crystal.



BIRDSYE VIEW OF THE TABLE MOUNTAINS (GOLDEN, COLO.) FROM MT. LOOKOUT.

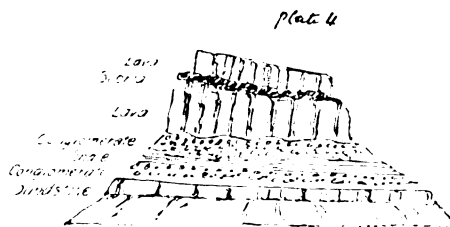


TABLE LAND OF SANDSTONES, SHALES, AND CONGLOMERATES CAPPED WITH LAVA.

vents falling into a lake, the waters of which stratified the debris into the forms known as volcanic andesitic tuff or breccia.

The material doubtless overwhelmed gradually the beautiful palmettos and other semi-tropical foliage growing on the edge of this lake or swamp at different periods of eruption, for we find many different beds of buried foliage at different levels. That the eruptions must have been vast and continued at intervals for a great period of time is evident from the thickness of material slowly accumulated for upwards of 800 feet. The curious feature of this is, that so far no dike or immediate source of this andesite eruption has been found nearer than South Park, about 100 miles distant.

After these eruptions had ceased and the thick lake beds of Tertiary andesitic tuff and breccia had been laid down, a fissure opened along the flanks of the mountains parallel with them from Rallston Creek, northward, and several successive flows of a different class of lava, viz., basalt, poured south and east, over the surface which was composed of the horizontal beds of andesite tuff, perhaps still covered by a lake. There were at least two successive flows, as marked by the beds of scoria resting on the surface of each flow, and there may have been more, as the mountain has suffered much since from erosion.

The external appearance of the basalt blocks is a reddish brown, from the oxidation of iron bearing minerals on the

through the thickness of the sheet resulting in rude polygonal columns.

On reaching the uneven rolling, flat top of the mountain, the surface is reticulated like a net with the polygonal cracks between the pillars, over the top of which we walk, as over a tiled pavement. The cracks are often filled with lava, or with curious oxidized or weathered structures. The surface of the lava soon disintegrates into a fine soil, at first by breaking up into little pellets from the size of a pea to that of a marble, and these again into gravel, and that into mineralogical and chemical elements forming a very rich and fertile soil, particularly adapted to the culture of grape vines, for which reason the slopes of Vesuvius and its volcanic surroundings have been celebrated for their vineyards.

Besides "tuffs" "breccias" and massive lava, volcanic glass or obsidian is often found in connection with basalt, resulting from great vitrification of the lava, and sudden or rapid cooling.

Paris Exhibit of the Jeffrey Mfg. Co.

The accompanying illustration shows the exhibit at The Paris Exposition of The Jeffrey Manufacturing Company, of Columbus, Ohio.

The exhibit was located in the American Building at Vincennes, and perhaps attracted as wide spread attention as any exhibit in

Vincennes, for the reason that, although the space allotted did not give an opportunity for adequate display, it gave those who were fortunate enough to visit Vincennes some idea of the great diversity of coal mining machinery and elevating and conveying machinery manufactured by this company.

The cut shows one of the 17-A electric chain mining machines, which have become standard the world over. Arrangements were made with the Exposition authorities, so that current was carried right to the exhibit, in order to allow the continuous running of this machine, thus giving the uninformed a new idea of the ingenuity which has been displayed in designing machines for working underground in coal mines.

There is also a 16-A air chain mining machine which is connected with compressed air pipes in the building, so that it also can be operated.

These two machines are a great novelty in Europe, for the reason that although efforts have been made by European engineers to design successful coal cutters, nothing as compact, powerful and efficient as the American machines has been seen in Europe before, save in the mines where American made machines had been installed.

The exhibit also shows the electric and compressed air rotary coal drills, which have attracted a great deal of attention, as they also were arranged so that power could be attached.

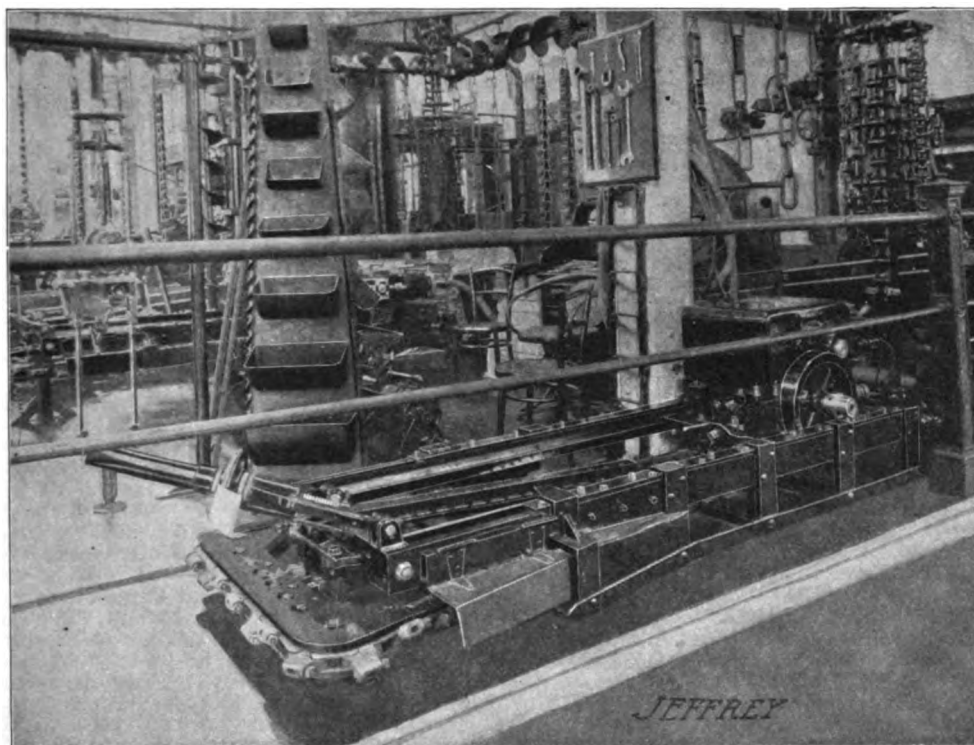
About the exhibit is arranged very artistically a fretwork of malleable and steel chains, which give the visitor an idea of the styles of chains used so extensively in this country for elevators and conveyors in factories, mills and mines of all kinds. French and German engineers constantly expressed their astonishment at the great assortment of chains for conveying and elevating purposes, and the great ingenuity shown in designing these chains for all kinds of conditions.

The very interesting exhibit also covers the different styles of elevator buckets, pan conveyors, screw conveyors, elevator boots, etc., which are too well known to need detailed description.

The Jeffrey Manufacturing Company is to be congratulated on having been given three Grand Prizes, by the Exposition authorities, which prizes cover their coal mining machinery, elevating and conveying machinery.

A very handsome catalogue covering the lines made by the Jeffrey Company, described in English, German, and French, the points which were of special interest to European engineers.

The exhibit was in charge of Mr. S. B. Belden, who has been for a number of years connected with that company, in charge of the Pittsburg Office.



PARIS EXHIBIT OF THE JEFFREY MFG. CO.

surface. In this surface crust are distinct black crystals dotted all over it, in little oblong spots about an eighth to a quarter of an inch in length; these are augite crystals, a mineral closely allied to hornblende, but generally not so long or slender in shape; with these are minute reddish specks of tiny black crystals of magnetite. The ground mass is a paste of plagioclase gray feldspar, with minute augite and magnetite crystals. On breaking the outer oxidized crust of the rock the interior is a dark blackish gray, showing very few distinct crystalline forms.

The different successive flows of massive basalt with their intervening scoriaceous soft beds, make that step-like division of the cliffs which earned the title of "trap" or stair, or step rock for many of these igneous lavas. The columnar structure is irregular; generally speaking the pillars are five sided, but vary, as also does the regularity of form of the column. Those of Table Mountain are quite rude and none of them so sharp and symmetrical as those of the Isle of Staffa, or of Fingal's Cave, which look as if they had been hewn out by machinery. The cause of the columnar structure is similar in many respects to that of the peculiar polygonal pattern of mud cracks in a drying up mud bank of a pond. In that case it is the result of contraction of a soft, wet, mass on drying around many centers. In the case of the lava it is the cooling and the contraction around a great number of centers in a molten mass that opens polygonal cracks, penetrating downwards

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Examination for Mine Foreman's Certificate for the State of Iowa, Held at Centerville, Iowa, Sept. 17-20, 1900.

Ques. 1.—What are the duties of a mine foreman?

Ans.—The mine foreman is the official above all others whose duty it is to see that every requirement of the mine law is complied with. To do this he must have a thorough knowledge of the law bearing upon the working of the mine in every detail. He should employ only such men as prove by their faithful and conscientious performance of their several duties that they are worthy of confidence. He must daily examine the working places of the mine, especially the more dangerous places; he must know that a sufficient amount of air is travelling upon the main airways and is being conducted to the several working places; he must know that each working place is supplied with a sufficient amount of timber of the proper size, for use in securing the roof in all working places, and that this timber is being used for that purpose by the men working at the face; he must know that the airways, travelling ways, and air courses are properly timbered and kept in a safe condition. It is the duty of the mine foreman to look after and insure the safety of all men employed in and about the mines; he must maintain discipline by a firm but kind demeanor toward all the men under his charge. Aside from these duties the mine foreman must see that the output of the mine is maintained in quantity and quality, and that a correct account is rendered of all expenditures for material and labor.

Ques. 2.—What are the essential laws pertaining to the ventilation and working of mines in Iowa?

Ans.—The essential laws in reference to the ventilation and working of mines in Iowa may be briefly enumerated as follows:

Iowa Code, Sections 2478-2484 inclusive, relate to the qualifications, examination, appointment, compensation, powers, duties, reports, and removal from office of the state mine inspectors. The law also requires that an accurate map shall be kept of each mine, showing the area mined or excavated, and shall be extended or brought up to date on or before the first day of September of each year. The map must be drawn to a scale not less than 100 feet to the inch, and kept exposed in the office of the mine, subject to public inspection. The law further provides for escape and air shafts, and allows one year in which to make such outlets, but restricts the number of men employed during that time to 20 men. The law requires that a circulation shall be maintained in the mine of not less than 100 cubic feet of air per minute for each person, and 500 cubic feet for each mule or horse employed. All mines operated by shaft or slope shall be provided with proper speaking tubes or signal apparatus extending from the surface to the shaft or slope bottom. Also, safety catches and covers to cages, safety gates, and brakes to winding drums, and trails or dogs attached to each train upon a slope or incline must be employed. The winding engine must be in charge of a sober and competent engineer, and not more than 10 persons are allowed upon any cage at one time. Boys under 12 years of age are prohibited from working in the mine. Sections 2490 and 2491 provide for the maintaining of suitable scales of standard make at all mines where payment is made upon the basis of the weight of coal mined. The weighman employed must be sworn to keep the scales correctly balanced, and to weigh accurately, and correctly record the weight of each car of coal delivered. The privilege is also secured to the miners of furnishing at their own expense a competent check weighman if they so desire. The law also specifies that where the miner is by contract to be paid by the ton or other quantity, unless otherwise agreed upon in writing, the owner or agent shall weigh the coal before screening and the miner shall be credited at the rate of 80 pounds per bushel and 2,000 pounds per ton, but no payment shall be demanded for sulphur, rock, slate, blackjack, dirt, or other impurities loaded or found in the coal.

Sections 2493-2495 provide that only pure animal or vegetable oil, paraffine, or electric lights shall be used for illumination pur-

poses in any mine. The standard of purity of oils is by law determined by the State Board of Health, such standard to be recognized by the courts of the state. Any oil used in the mine is subject to the test of the state mine inspector. Penalties are attached for the non-performance of these duties. A recent law enacted by the last legislature (March 1900) makes it necessary for all mine foremen and hoisting engineers to have a certificate of competency, and provides for the examination of men desiring such certificates.

Ques. 3.—Will coal dust influence a mine explosion? If so, how?

Ans.—Wherever coal dust in a finely divided state is present in a considerable quantity in mine workings, either at the face or along the mine passageways or haulage roads, it is thrown more or less into suspension in the air of the mine by the velocity of the air current and the travelling of men and animals and the haulage of loaded cars, and when subjected to the force of a blast. The influence of any considerable amount of coal dust held in suspension in the mine air is: (1) To render explosive a small amount of gas present in the atmosphere and which would not otherwise be explosive. (2) To lengthen or extend the flame of an explosion of gas in the mine. The flame of an explosion is thereby often carried from one point to another point in the mine, which points would be isolated from each other were it not for the coal dust held in suspension in the airways connecting them. Separate and distinct explosions of isolated bodies of gas are thus effected by dust held in suspension in the air. Coal dust when acted upon by a considerable body of flame, either of a blast or explosion of mine gas, is converted into carbonic oxide gas (CO), which is combustible and which propagates or transmits the flame of a blast or explosion. (3) An explosion of mine gas in the presence of fine dust is intensified and rendered more violent than would otherwise be the case. (4) The presence of fine coal dust in the vicinity of blasting may produce an explosion of gas. The dust thrown into suspension by the force of the blast is ignited by the flame of the explosion and gasified; the force of the gas explosion which ensues throws more dust into the air, which furnishes the means for the production of more gas, and extends the explosion in the mine. A blow-out or a windy shot occurring under these circumstances is almost certain to produce a gas explosion of considerable proportions.

Ques. 4.—Which do you consider should be the larger, the upcast or the downcast shaft, and why?

Ans.—The upcast shaft of a mine should always have a larger sectional area than the downcast shaft, for the reason that under the conditions of mining the return current almost invariably has a larger volume than that of the intake. The volume of the return current is increased in the following ways: (1) By the mine gases which are produced constantly in the mine workings and in the waste or abandoned places in the mine. (2) During a large portion of the year, especially in the winter season, the temperature of the return current is greater than that of the intake. As a result of this higher temperature the volume of the return air is greater than that of the intake current. (3) The return air of any circulation, whether exhausting or blowing, is always subject to a less pressure than the intake air, and as a consequence its volume is thereby slightly increased. [This increase of area should be determined according to the gaseous condition of the mine in connection with the increased temperature of the upcast current. A safe rule in determining the area of the main return airway at the foot of the upcast shaft is to divide the quantity of air in circulation by a velocity not exceeding 25 feet per second (1,500 ft. per min.). The area of the upcast should not be less than half of this area, under any circumstances, making the maximum velocity of the upcast current in the shaft, 50 feet per second, or 3,000 feet per minute.]

Ques. 5.—What are the different noxious gases found in the coal mines of Iowa? Give as fully as possible what is known of the properties, dangerous character, and methods of detecting each of them.

Ans.—The noxious gases existing in the coal mines of Iowa are as follows: Carbonic acid gas (blackdamp), CO_2 ; carbonic oxide gas (whitedamp), CO ; sulphureted hydrogen, (stinkdamp), H_2S ; afterdamp, or a mixture of these several gases and the nitrogen of the air, occurring as the result of an explosion of mine gas.

Carbonic Acid Gas (Blackdamp), CO_2 .—This gas is one and one-half times as heavy as air, at the same temperature and pressure, having a specific gravity of 1.529. This gas is not combustible; when present in any considerable quantity it dims and eventually extinguishes the flame of a lamp; it also reduces the explosiveness of other gases or explosive mixtures when present in them. It is not poisonous, but causes death by suffocation by excluding the oxygen of the air from the lungs. The effect of breathing carbonic acid gas is to cause headache, nausea, and pains in the back and limbs, followed by unconsciousness and death by suffocation. This gas is detected by the dim burning and shortening of the

flame of a lamp, or its entire extinguishment. A less quantity of the gas sometimes produces a sweet taste in the mouth when breathed for a considerable length of time.

Carbonic Oxide Gas, (Whitedamp), CO.—This gas is somewhat lighter than air, having a specific gravity of .967. It is combustible, burning with a light blue flame tending to a violet. In the presence of a considerable amount of this gas the flame of a lamp is extended and reaches upward in a taperlike blaze sometimes surmounted by a blue cap. Lamps burn more brightly when this gas is present in the mine air. Carbonic oxide gas is a poisonous gas absorbing oxygen from the blood. It causes headache, pain in the back and limbs and unconsciousness and death if the victim is not rescued immediately. The effect of the gas upon the flame of a lamp is to cause it to be extended and to burn with unusual brightness, and furnishes the best index of the presence of the gas in the mine air.

Sulphureted Hydrogen (Stinkdamp), H_2S .—This gas though usually found in small quantities is of a dangerous character. It is heavier than air, having a specific gravity of 1.1912. The gas burns with a bluish flame, and is highly explosive when mixed with seven times its volume of air. This gas is very poisonous, destroying the oxygen of the blood and quickly deranging the system. Its smell, which resembles that of rotten eggs, furnishes the best evidence of the presence of the gas in mine workings.

Afterdamp.—This is any mixture of noxious gases resulting from the explosion of mine gas, and consists largely of the nitrogen of the air mixed in varying proportions with carbonic oxide gas (CO), carbonic acid gas (CO_2), and some small amounts of various hydrocarbons. Marsh gas, CH_4 , often called firedamp is not found in the mines of Iowa.

Ques. 6.—What is the use of the anemometer, water gauge, and compass in connection with coal mining?

Ans.—The anemometer is used to determine the velocity of an air current. A point is selected in the airway where the velocity of the air is uniformly distributed, and the sectional area of the airway at this point is carefully measured. The anemometer is then here exposed to the air current by moving it carefully into different positions in the airway, and observing its reading after a given length of time, say 4 or 5 minutes. The area of the airway (sq. ft.) is then multiplied by the velocity of the air (ft. per min.) to obtain the quantity of air in circulation.

The water gauge.—The water gauge is used to measure the ventilating pressure in any circulation of air in an airway, the ventilating pressure or the pressure causing ventilation in any airway being the difference between the intake and return pressures.

The compass is an instrument used for determining the course or direction of a line in a mine, by means of a magnetic needle. In using the compass the line of sight is made to conform to the line whose bearing is sought. The reading of the needle is then observed when it has come to rest, and this reading represents the bearing or course of the line.

Ques. 8.—How would you proceed to reduce the number of doors in a mine and still maintain a good circulation of the air? What advantage would be gained by so doing?

Ans.—The number of doors required in the ventilation of a mine is reduced to a minimum by dividing the air upon the main

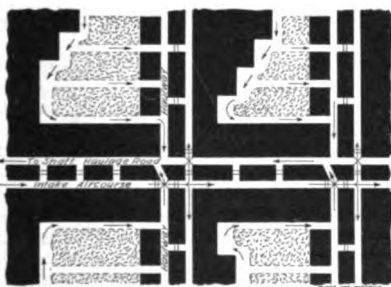


FIG. 1.

intake airway, at the mouth of each district, thereby giving to each district its own circulation. An overcast will be required at the mouth of each district, either upon the intake or return airway. Fig. 1 represents a plan of a mine where the haulage road is made the return airway. The plan shows an overcast at the mouth of each district by which the intake air is carried over the haulage roads. The advantage of reducing the number of doors to a minimum in the ventilation of a mine is that the danger is avoided of doors being set open and the circulation deranged or completely destroyed, for any one district. The expense for trappers is also avoided and the main haulage road of the mine is unobstructed. (See Air-Crossings, Or Air-Bridges, page 235.)

Ques. 7.—In case of an accident in which a miner has received a wound severing an artery, what would you do to prevent hemorrhage before a physician arrives?

Ans.—In case the wound is in the arm or leg, a rope or strong bandage is tied tightly around the wounded member between the wound and the heart. A short stick is inserted under the bandage, and the latter tightened by twisting the stick. A small pad,

block, or stone, is also inserted under the bandage, in such manner as to press against the severed artery to stop the flow of blood from the heart to the wound. In case several small arteries are severed and the wound is in such a part of the body where the flow cannot be readily stopped in this manner, it is usual to apply sulphate of iron to the wound either in powdered form or in a strong solution by means of a sponge. The sulphate of iron coagulates the blood and stops the flow. In case of bleeding from the lungs, when the blood is coughed up, the only recourse is to insist upon perfect rest in a cool bed with head and shoulders raised. Let the patient swallow small pieces of ice and restore his confidence as far as possible by assuring him there is no danger. Bleeding sometimes occurs from the stomach, when the blood looks dark and clotted. Give small pieces of ice to swallow and ice water to drink, and several doses of a teaspoonful of vinegar at short intervals, also place cracked ice wrapped in a towel over the stomach. In all cases send for a physician at once.

Ques. 9.—If a fan making 100 revolutions per minute produces 40,000 cubic feet of air, how much air should the same fan produce when its speed is increased to 125 revolutions per minute?

Ans.—It is usually assumed that the quantity of air in circulation is in proportion to the number of revolutions the fan makes per minute. This would give for the quantity of air produced by this fan, at a speed of 125 revolutions per minute, $100 \times 40,000 = 50,000$ cu. ft. In practice this amount will hardly be realized. [The quantity of air is probably more nearly in proportion to the fifth root of the fourth power of the number of revolutions per

minute. Thus, $\sqrt[5]{\left(\frac{125}{100}\right)^4} \times 40,000 = 47,818$ cu. ft. (See Conditions In Mine Ventilation, page 234.)]

Ques. 10.—In case of an explosion in a mine whereby the doors and air stoppings are destroyed, what method would you adopt to restore circulation?

Ans.—In case of an explosion that has destroyed the doors and air stoppings of a mine, in fan ventilation, a hurried examination is first made of the fan, to make certain that it is still performing its work. If the fan has been injured by the force of the explosion, it must be repaired at once in a temporary manner, so as to secure a current of air in the mine. Meanwhile a call for volunteers has been made and a party of rescuers proceeds to enter the mine by the intake opening wherever this may be. It would be hazardous or impossible to enter the mine by any other opening. The rescuers are usually divided into an exploring party and a party whose duty it is to make necessary repairs. The explorers cannot advance farther than they are able to obtain fresh air, owing to the danger of being overcome by the whitedamp, which though unsuspected is almost always present, and in which the lamps of the rescuing party continue to burn brightly. Whitedamp or carbonic oxide gas (CO) is the most dangerous of the mine gases, because of its poisonous properties and of its presence being unsuspected. The air is carried forward by temporary brattices and the making of such repairs are absolutely necessary. Where many stoppings are destroyed or an air course is closed by a fall, a line of brattice is constructed along one side of the entry by stretching brattice cloth upon posts set temporarily, a short distance from one rib of the entry. Any temporary method is resorted to by which the air is carried forward in the quickest and most direct manner to the working face.

In furnace ventilation or in cases where the ventilator is destroyed, it may be possible to secure temporary ventilation by pouring water down the downcast shaft, or by lowering a steam jet into the upcast shaft. The upcast shaft should in such cases be protected from the force of the wind at the surface, while the downcast shaft is so arranged as to deflect the surface wind into the intake of the mine. Any or all of these measures should be employed in the attempt to restore ventilation temporarily.

Ques. 11.—Give the comparative advantages and disadvantages of the longwall, and room and pillar methods of working a coal mine?

Ans.—As compared with the room and pillar method of working, the longwall system possess the following advantages: (1) All of the coal is extracted in the first working. (2) The settlement of the surface is gradual and uniform. (3) There is no expense for narrow work. (4) The mine is more easily and efficiently ventilated. (5) There is a minimum liability to gob fires. (6) A larger percentage of lump coal is obtainable. (7) The risk of squeeze or creep is avoided. (8) The cost of haulage and timbering is reduced to a minimum. (9) Ample room is afforded for the storage of waste instead of hoisting the same to the surface. The longwall system should be employed whenever the conditions are favorable to its adoption. The only conditions under which the room and pillar system possesses any advantage over the longwall system is in the working of a gaseous seam of coal where the room and pillar system affords opportunity for isolating the

different districts of the mine, either as separate panels or separate circulations. This system is also used in shallow seams where the roof pressure is not great; or where the roof is strong and unyielding and not adapted to the longwall method; or there is not sufficient refuse for building packs, and upon steep pitches. The disadvantages of the room and pillar system as compared with longwall are numerous and may be stated as follows; increased cost of haulage, timbering and dead work, greater liability to squeeze, gob fires, and surface damages; the production of an increased percentage of screenings.

Ques. 12.—Suppose the cross entry from which rooms are turned runs at an angle of 45° to the main entry, what distance would have to be measured on the cross entry to get rooms 20 feet wide, with 12 ft. pillars between them, when the rooms are made parallel to the main entry?

Ans.—The distance from center to center of the rooms measured upon the cross entry is found thus, $\frac{20 + 12}{\sin 45^\circ} = \frac{32}{.7071} = 45.25$ ft.

Ques. 13.—Explain the principles of construction and mode of action of a water gauge.

Ans.—The water gauge is simply a glass U tube open at both ends. Water is placed in the bent portion of the tube, and stands at the same height in both arms of the tube when each end of the tube is subjected to the same pressure. If, however, one end of the tube is subjected to a greater pressure than the other end, the water will be forced down in that arm of the tube, and will rise a corresponding height in the other arm, the difference of level in the two arms of the tube representing the water column balanced by the excess of pressure to which the water in the first arm is subjected. An adjustable scale graduated in inches measures the height of the water column. The zero of the scale is adjusted to the lower water level, and the upper water level will then give the reading of the water gauge. One end of the glass tube is drawn to a narrow opening to exclude dust, while the other end is bent to a right angle, and passing back through the standard to which the tube is attached, is cemented into the brass tube that passes through a hole in the partition or brattice, when the water gauge is in use. The bend of the tube is contracted to reduce the tendency to oscillation in the height of water column.



FIG. 2.

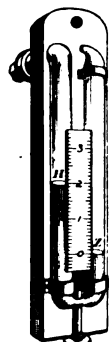


FIG. 3.

When in use, the water gauge must be in a perpendicular position. It is placed upon a brattice occupying a position between two airways. The brass tube forming one end of the water gauge is inserted in a cork, and passes through a hole bored in the brattice as shown in Fig. 2. The water gauge must not be subjected to the direct force of the air-current, as in this case the true pressure will not be given. The reading of the water

gauge shown in Fig. 3 is 2 inches. Each inch of this water gauge column or reading represents a ventilating pressure per square foot of area in the intake airway of 5.2 pounds. The total ventilating pressure in pounds is therefore found, by multiplying the water gauge or reading in inches by 5.2; thus two multiplied by 5.2 equals 10.4 pounds, all of the pressure per square foot in the airway.

Ques. 14.—Suppose you have three pairs of entries, each the same distance from the downcast shaft. One runs to the dip, one is on the level, and the third is to the rise. Which pair will be the most easily ventilated, and why?

Ans.—Assuming that the air of the mine has a higher temperature than the outside air, the temperature of the return current in each of the three pairs of entries named will be higher than that of the intake. As a result there will be formed in both the rise and the dip entries, natural air columns. The air column of the dip entry will assist ventilation, since the lighter return air rises as it travels. The air column of the rise entry will, on the other hand, retard ventilation, because the lighter return air, in this case, falls as it travels. The natural air column formed in the dip entry, acting to assist ventilation, will render this pair of entries more easily ventilated than either of the others; while the air column formed in the rise entry, acting to retard ventilation, will render the ventilation of that pair of entries the most difficult.

Ques. 15.—Explain how a true meridian is determined.

Ans.—A true meridian upon the earth's surface, is the intersection with the surface of the earth of a plane passing through

the axis of revolution. This is a true north and south line. In practice there are two methods for determining a true meridian. One is by the use of the solar attached to a transit, and another by reference to the position of the North Star. The North Star not being coincident with the poles of the earth or the extended axis of revolution of the earth, has an apparent revolution about the north pole. Twice in a stellar day (24 hrs.) the position of the North Star coincides with the true meridian, and likewise twice it is at its greatest distance from the north pole. This distance is called its polar distance, and the star is then said to be at *elongation*, either *east* or *west*. If it were possible to determine the exact time when the star crossed the meridian, its position at that time would determine the true meridian; but the position of east and west elongation is more readily obtained, since the star appears to move from the pole until it obtains its greatest elongation, and at that point appears to remain stationary for a few moments and then recede. The east and west elongation are therefore easily obtained by observing the motion of the star, with a transit. The polar distance of the North Star at any given date may be taken from a nautical almanac. The sine of this polar distance, divided by the cosine of the latitude of the place, will give the sine of the azimuth of the star. The position of the star when at elongation is then corrected by this azimuth angle, to obtain the true meridian of the place. The polar distance of the North Star for January, 1900, is $1^\circ 13' 30''$. This polar distance is decreasing at the rate of $19.08''$ each year. Some 10 minutes before this time the transit is carefully set up and leveled over a peg. The cross-wires are made to bisect the star; they are illuminated by a light held under the reflector fastened on the object end of the telescope. The star is followed with the cross-wires until its motion toward the point of its greatest elongation ceases. The telescope is lowered vertically, care being taken, of course, not to move it horizontally, and a peg is set up on the line, say 300 ft. or 400 ft. distant. The next morning the correction is made for the star's azimuth.

To Find the True North With the Burt Solar.—“Find from an ephemeris or nautical almanac the sun declination for noon of the day of observation at Greenwich. Find the declination for the hour of observation at the place of observation by first figuring what time it is at the place of observation when it is noon at Greenwich. If the place of observation is west of Greenwich, it will be earlier there; if east, later, and in either case the difference will be one hour for every 15° of longitude. If the place is west, subtract the hour just found as described from the hour of the observation, and multiply the hourly difference, also taken from the ephemeris, by the remainder. If the declination is increasing from the equator either north or south, add this product to it; if decreasing, subtract it. A table of refractions is given in the ephemeris for the different latitudes and the different hours of the day. This refraction is to be added if the declination is north, and subtracted if the declination is south. Having thus ascertained the declination, lay it off on the declination arc. Set the colatitude of the place off on the vertical arc after having leveled the instrument carefully with clamped horizontal plates at zero. Always in solar observations it is well to level by means of the upper telescope bubble. Now, revolve the horizontal plates still clamped, and also the declination arc, around its polar axis until the sun's image is exactly between the horizontal lines of the silver plates. When the sun's image is between these lines, the object end of the telescope will be pointing north.—*Coal and Metal Miners' Pocketbook*, 6th Edition.

Ques. 16.—What are the advantages of a transit over a compass in making a mine survey?

Ans.—One advantage which a transit possesses over a vernier compass, for surveying in a mine, consists in the greater accuracy of sighting with the former, the transit being provided with a telescope, while the compass is provided with sights only, consisting of two vertical slits in uprights attached to the graduated circle of the compass; one of the slits being provided with a horse-hair or fine wire. Again, the vernier of a compass is often arranged to only admit of a small angle being turned off or deflected, while with a transit the telescope may be deflected through any angle. The telescope of a transit may also be elevated or depressed, which gives it a great advantage over the compass in surveying inclined seams. Also, the graduations of the circle and of the vernier are finer and more accurate in a transit than in a compass. In other respects, a vernier compass is equal to a transit for ordinary mine surveying.

Ques. 17.—What will be the reading of the water gauge, when the pressure per square foot is 20 pounds?

Ans.—The reading of a water gauge, in mine ventilation, is calculated from the pressure per square foot (pounds), thus,

$$w. g. = \frac{p}{5.2} = \frac{20}{5.2} = 3.846 \text{ in.}$$

Ques. 18.—Does a large volume of air always require a high water gauge for its circulation in a mine? Why?

Ans.—No; the same water gauge will pass a larger or a

smaller volume of air, according as the resistance offered by the mine airways is less or greater. The water gauge reading or pressure per square foot, varies directly as the amount of rubbing surface, and inversely as the cube of the sectional area of the airway, for the same quantity of air in circulation.

QUES. 19.—Explain as far as possible, the causes of personal accidents in mines.

ANS.—The most prolific source of personal accidents in mines, is due to falls of roof or coal. This is very largely the result of ignorance or carelessness upon the part of the miner himself. There is a natural tendency on the part of the miner to postpone the setting of necessary timber before loading out his coal, and he is thus exposed to the danger of falls while cleaning up his place. Roof slips dipping forward over the breast coal, often result in serious accidents, since their presence is unknown to the miner and a fall of roof occurs without warning. Neglect to properly sprag coal while mining the same causes many accidents. Again, many accidents occur in blasting coal from going back too soon to ascertain the cause of a mis-shot, from the careless use of iron bars in tamping or stemming a shot, and from the neglect to warn men in adjacent working places when firing a blast. Accidents due to the explosion of a body of gas are too often due to carelessness arising from the use of naked lamps or tampering with a safety lamp or exposing a safety lamp to a strong current of air and gas, or from any improper use of a safety lamp. Accidents due to the movement of loaded cars often occur from neglect to properly sprag the car upon a steep grade, or from the derailment of cars in transit. Accidents from falling down shafts or steep inclines may result either from carelessness or from the breaking of ropes, etc.

QUES. 20.—If the length of an airway be doubled, while the ventilating pressure remains the same, how much will the volume of air in circulation be reduced?

ANS.—For the same ventilating pressure, the quantity varies inversely as the square root of the length of the airway. If the length of the airway be doubled, the pressure remaining the same, the quantity will vary in the ratio $\frac{1}{\sqrt{2}} = .7071$; or the quantity passing in the longer airway will be .7071 times the quantity in the shorter airway, under the same ventilating pressure.

The Meridian of a Survey.

The most important line in a survey is the meridian to which the survey is referred. A meridian line as generally understood is a true north and south line, or a line determined by the intersection with the surface of the earth, of a vertical plane through its axis of revolution. The term meridian, however, as used in surveying, may refer to the true meridian just described or to the magnetic meridian, which is the line corresponding to the direction of the magnetic needle, at that place; or it may mean any line assumed as the meridian of the survey. An assumed meridian may be a north or south line, approximately; or may have any direction whatsoever. When a line is assumed as the meridian of a survey, the bearings of all the courses of the survey are referred to this line as north and south. This method of surveying, by referring the survey to any assumed meridian, is often used below ground when the true meridian is not known, and until the underground survey can be connected with the surface survey or with a true meridian upon the surface. The necessary corrections are then made in all of the courses of the survey underground. Such a survey referred to any assumed meridian

is as complete in itself as though referred to the true meridian; and may at any time be referred to the true meridian by applying the same correction to all the bearings or courses of the survey, such correction being the angle that the assumed meridian makes with the true meridian.

There are two points that especially interest the surveyor,

in reference to the meridian. (1) The determination of a true meridian upon the surface. (2) The manner of establishing a true meridian in a mine open by a shaft. All government surveys are referred to the true meridian of the place. This is usually determined by the use of the solar attached to a transit; or by the direct observation of the sun with the telescope of the

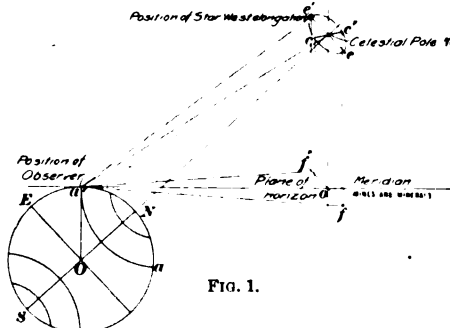
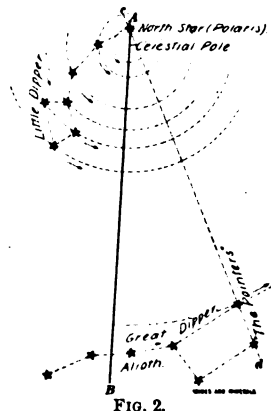
transit. In the latter method there is obtained by calculation what the solar arrives at mechanically. The attachment called the solar attachment is not only expensive but cumbersome, and requires considerable skill in its use. Neither of these methods is employed generally by surveyors or engineers for the determination of the true meridian of a place except by government engineers. We will not therefore discuss these, but will describe briefly the manner of determining the true meridian, at any place, by observing the North Star, Polaris. This star is a small star having a position very close to the celestial pole, in the northern hemisphere. Indeed, its position is so close to that of the celestial pole that for general purposes, it is often considered as coincident with the pole. The revolution of the earth upon its axis once in 24 hours or a solar day, makes this star appear to revolve about the pole in a like period of time. It is thus apparent that the star, during this period, will be twice in the meridian plane, once above the pole or toward the zenith of the heavens, and once below it. These points are called the *culmination* of the star. In like manner it will, in the same period, be twice at *elongation*, or at points of its apparent orbit a quadrant's distance from culmination. The elongation of the star is thus either east or west. The observed angle between the pole and the star at elongation either east or west, is called its *polar distance*. The polar distance of the North Star for January, 1900, is $1^{\circ} 13' 30''$, and is decreasing at the rate of $19''$ each year.

Fig. 1 illustrates in an imperfect way the manner of observing the position of the North Star, at its western elongation e' . The position of the observer upon the earth is at a' , N and S being the poles of the earth, and n the celestial pole, c and c' are the points of culmination, and e and e' the points of elongation, in the star's apparent orbit. The diameters $c c'$ and $e e'$ of this orbit are at right angles to each other; the former being projected upon the horizontal plane or the plane of the horizon, along the line $a' o$, and the latter at $f f'$. It is plain that the points of culmination c and c' lie in the vertical plane $n o a'$ or in the meridian plane, and that $a' o$ is the true meridian at a' . The polar distance of the star at western elongation, is the angle $n a' e'$, while the vertical angle $o a' n$ is equal to the latitude of the place or the angle $E O a'$; and the horizontal angle $o a' f'$ is the azimuth of the star.

It is clear at once that, if we knew the exact moment when the star was at culmination or when it crossed the meridian plane, its position at that time would determine the meridian $a' o$. The means at the disposal of the surveyor, however, for determining exactly the time of the culmination of the star are imperfect and give only approximate results and we therefore cannot determine the meridian exactly by this means. We observe, however, that the star continues to move until it reaches its point of western elongation, or its greatest distance from the celestial pole. At that moment, if we have carefully sighted its position through the transit, we observe it appears to remain stationary for a short period and then to recede. The extreme position of the transit thus determines exactly the vertical plane $a' f' e'$; and we locate carefully upon the ground a point in the line $a' f'$. As previously stated, the polar distance of the star at elongation in January, 1900, is $1^{\circ} 13' 30''$. This is the angle $n a' e'$, and the horizontal angle $o a' f'$ or the azimuth of the star is calculated from the polar distance, by the formula, $\sin \text{azimuth} = \frac{\sin \text{polar distance}}{\cos \text{latitude of place}}$.

Observe carefully that the polar distance is decreasing at the rate of $19''$ per year, and should be corrected to agree with the time of observation. Having calculated the horizontal angle $o a' f'$ or the azimuth of the star, this angle is laid off very carefully with the instrument from the line $a' f'$, determined by observing the star at elongation, and the position of the meridian $a' o$ is thereby determined.

After a little study it will be readily observed that the position of the star at eastern elongation cannot often be observed at the same time of the year as its position at western elongation. For example, suppose we observe the star at western elongation, at 12 o'clock midnight, in its position at e' , or to the left hand of the celestial pole. Twelve hours later, or at noon of the following day, the earth has made half of a revolution, and the position of the observer is now at a . The star having remained stationary would appear to be to the right of the celestial pole or at eastern elongation; but it being day the observation cannot be made. In order for the observation to be made in this position, or with the star at eastern elongation, the earth must be upon the other side of



the sun. This will be the case in about six months from the time of the first observation, or when the earth has performed a half of its revolution about the sun. From this position of the earth in its orbit, the star will be observed at east elongation at night, and its west elongation will occur in the day and be unobservable. Should we carefully observe and mark the line $a'f'$ at one season of the year, when the star is observable at night at its west elongation, and likewise, at another season, carefully determine and mark the line $a'f$, when the star is observable at its eastern elongation, the position of the true meridian $a'o$ would lie nearly half way between these two lines being nearer the later mark by the amount the azimuth of the star has decreased since the first observation; and the angle $fa'f'$ will be the sum of the two azimuths of the star. We will explain the method of establishing a true meridian underground, or the manner of connecting the underground survey with the survey upon the surface, in another article.

This article would not be complete without giving the general reader such information as would assist him in locating the North Star or the star Polaris, in the heavens. As commonly as this star is referred to there are a large number of people who are unable to point out its position in the heavens, with any degree of accuracy and assurance. It would be difficult to describe the position and the manner of locating the star without assuming a certain knowledge on the part of the observer, in regard to the more important of the constellations or groups of stars. For example, we may assume that any person of ordinary intelligence knows or can acquaint himself with the constellation commonly called the Great Bear or Great Dipper. It will be perhaps somewhat more difficult to locate, in a familiar manner, the constellation known as the Little Bear or Little Dipper. Both of these constellations, however, are easily found in the heavens, after a little practice. For the purpose of assisting one who is not familiar with the heavens, we have drawn Fig. 2, representing the relative position of the chief stars forming these two constellations. It will be observed from the figure that the two end stars in the bowl of the dipper, serve as pointers to locate the position of the North Star. For this reason they are often called "The Pointers." We have drawn the dotted line cd to indicate the manner in which these two stars serve to point out or locate in the heavens the position of the North Star. Fig. 2 represents these two constellations as viewed from any position upon the earth's surface looking toward the northern celestial pole at the time of culmination of Polaris. The point marked Celestial Pole indicates the position of the pole, and is the center about which all the other stars appear to revolve in concentric circles. We have drawn some dotted lines to indicate the circles which these stars describe about the pole. The motion of the stars is, however, only apparent, caused by the revolution of the earth upon its axis. It will be observed that the direction in which the stars revolve is contrary to that of the clock, the motion being to the west when above the pole and to the east when below it. The North Star (Polaris) is the closest of all the stars to the pole, revolving about it in a small circle. All the stars revolving about the Celestial Pole cross the meridian AB twice in each revolution or polar day, once above the pole and once below it. When it crosses the meridian a star is said to culminate. In Fig. 2 the star Polaris is represented at its upper culmination, above the pole, while Alioth is shown as having passed its lower culmination a few minutes previous.

The fact that Alioth is almost exactly opposite to Polaris and consequently culminates but a few minutes previous to the culmination of Polaris, enables us to use these two stars as a means of determining the meridian at any place. For example, if we suspend a plumb bob in a place where it will be protected from the wind, and keeping Polaris exactly behind the string, from our point of sight observe the time when Alioth culminates or passes behind the string, the vertical plane passing through the plumb line and these two stars will vary from a true meridian plane by only $11'$. Now, if after thus observing the passage of Alioth behind the string, we wait $24\frac{1}{2}$ minutes longer, Polaris will then be at its exact point of culmination, and the plane passing through Polaris in this position and the plumb line will be a true meridian plane. Alioth has in the meantime moved several degrees to the right of the string and we are not longer concerned with its position.

While this method is not as accurate a determination of the meridian as that previously described, it is certainly one that will prove useful to the practical man who desires to know the direction of the true meridian at any place. It is accomplished without any instrument other than a simple plumb line. The first observation notes carefully the time when the two stars are exactly behind the string. In the second observation made $24\frac{1}{2}$ minutes later, a stake is driven exactly on line with the string, while keeping in line with Polaris; in other words the stake is driven in the meridian plane passing through the plumb

line and Polaris; and the line joining the plumb line and the stake is then a true meridian line. This method will give results that are very close for all practical purposes, such as observing the variation of the needle of a compass, and will be found very useful. The method by elongation is more accurate, and should always be used in working with a transit, when it is possible to observe Polaris at its time of elongation. At certain seasons of the year, however, for a few days at a time, the elongation of Polaris either east or west is not observable on account of its occurring too closely to sunrise or sunset.

For convenience, and for the purpose of knowing beforehand at what time the observation of Polaris and Alioth, as just explained, can be made at different seasons of the year, the following table is given, showing the time of the upper culmination of Polaris for each month and half month throughout the year. The time of culmination will be found to vary regularly, being about $3' 56''$ earlier each day. This is owing to the sidereal day being about $3' 56''$ shorter than the solar day, caused by the advance of the earth in its orbit or path around the sun. The above table is given merely as a guide to the time of making the observation, and not to indicate the exact time of the culmination of the star which varies slightly from year to year, for the same day of the year. It must be remembered that the passage of Alioth observed in the first observation is $24\frac{1}{2}$ minutes earlier than the time given in the table. It must also be remembered that the time given in the table is mean sun time for any place, and is therefore $4'$ later than standard time, for each degree of longitude the place is west from the longitude of standard time.

TABLE SHOWING THE TIME OF CULMINATION OF THE NORTH STAR (POLARIS) FOR THE YEAR 1900.

Date. 1900.	Time of Culmination. (Mean Sun Time.)
January 1.....	6.36 P. M.
January 15.....	5.41 P. M.
February 1.....	4.34 P. M.
February 15.....	3.39 P. M.
March 1.....	2.43 P. M.
March 15.....	1.48 P. M.
April 1.....	12.41 P. M.
April 15.....	11.42 A. M.
May 1.....	10.40 A. M.
May 15.....	9.45 A. M.
June 1.....	8.38 A. M.
June 15.....	7.43 A. M.
July 1.....	6.40 A. M.
July 15.....	5.46 A. M.
August 1.....	4.39 A. M.
August 15.....	3.44 A. M.
September 1.....	2.38 A. M.
September 15.....	1.43 A. M.
October 1.....	12.40 A. M.
October 15.....	11.45 P. M.
November 1.....	10.38 P. M.
November 15.....	9.43 P. M.
December 1.....	8.40 P. M.
December 15.....	7.45 P. M.

Time in the United States is referred to four standards or meridians of longitude. Eastern time is referred to the longitude 75° west from Greenwich; Central time, 90° west from Greenwich; Mountain time, 105° west from Greenwich; and Western time, 120° west from Greenwich. These standards are 15° of longitude or one hour apart. It will always be necessary in making an observation upon Polaris, to correct the standard time in use at any place, according to the longitude of the place, as previously stated.

Conditions in Mine Ventilation.

A study of mining conditions is always essential or absolutely necessary to a correct solution of mining problems; especially is this true in mine ventilation. We often see it stated that in any circulation the pressure varies as the square of the quantity, or the quantity varies as the square root of the pressure. This rule is not always understood as referring to a given airway, as it should, and is frequently misapplied. For example, If 10 horsepower is required for the circulation of 40,000 cubic feet of air in a given mine under a water gauge of 1.586 inches, what quantity will the same power produce in a mine where the water gauge is 3 inches; or again, If a given fan produces a circulation of 50,000 cubic feet of air under a $2''$ water gauge, what quantity will this fan produce under a $4''$ water gauge, the power applied to the fan-shaft remaining the same? To solve either of these examples by the rule that the quantity varies as the square root of the pressure would be evidently wrong, since the power in each case remains the same. The expression for power (work per minute) in terms of the quantity and pressure in ventilation is $u = qp$, from which it appears that, for a constant power the quantity varies inversely as the pressure; thus, in the first example the quantity produced

with a water gauge of 3 inches would be $\frac{1.586}{3} \times 40,000 = 21,146$ cubic feet; and in the second example, the quantity produced by a 4-inch water gauge would be $\frac{2}{4} \times 50,000 = 25,000$ cubic feet.

Again, the statement is often made that the splitting of an air current into two equal splits will result in doubling the quantity of air in circulation. This statement is never absolutely true, and under some conditions is very far from the truth. In fan ventilation where the power applied to the fan-shaft remains constant, the splitting of the air current into two equal splits, at the foot of the downcast, would result in doubling the quantity of air

in circulation in the mine, were it not for the increased resistance in the shafts and in the fan when the sectional area of the mine airway is doubled by forming two airways for the passage of the current instead of one. But, on account of the increased resistance in the shafts and in the fan, the quantity of air in circulation falls short of double the original circulation. On the other hand, in furnace ventilation where the pressure remains constant, the effect of splitting the air current into two equal splits at the foot of the downcast, disregarding shaft resistance, is to increase the quantity of air in circulation $\sqrt{2}$, or in this case $2\sqrt{2} = 2.828$ times. This is one of the important differences between fan and furnace ventilation, which we should carefully observe.

It is often stated that the resistance of a mine is decreased by splitting the air current. This is an error. In furnace ventilation, assuming that the air is split at the foot of the downcast and ignoring shaft resistance, the mine resistance is increased as many times as the number of splits, the resistance of each of the equal splits being the same as the resistance of the original undivided airway. In fan ventilation the mine resistance would remain the same were we to disregard the increased resistance of the fan and shafts. But on account of the increase of resistance in the fan and shafts, the power applied to the splits is somewhat decreased, and as a consequence the mine resistance is decreased slightly. The increase of resistance in the fan and shafts in almost every case exceeds the decrease in mine resistance, and the total resistance is increased. It is this increase of resistance or load upon the fan that causes it to run slower when we might expect it to run faster under the decreased mine resistance, the power applied to the fan-shaft remaining the same. This is one of the seeming anomalies of mine ventilation.

There is another point in fan ventilation that is often misunderstood on account of a lack of study of the conditions. This is expressed in the rule often given to define the relation that exists between the speed of a fan and the volume of air which it produces. The rule here referred to is that the quantity of air produced by any given fan is proportional to its speed of revolution, or the number of revolutions per minute. We have seen many statements of inquiry in reference to the yield obtained from the same fan running at different speeds, which did not at all conform to the rule stated above. For example, a 14-foot fan, at a given mine, driven at a speed of 70 revolutions per minute, yields a volume of 50,000 cubic feet of air per minute, under a given test. Later, in the development of the mine, another test made upon the same fan, at the same speed, shows a volume of, say only 30,000 cubic feet of air in circulation. Or again, two mine superintendents meet to compare notes; they each have a 20-foot Guibal fan in operation at their respective mines. In the one case the fan running at a speed of 50 revolutions per minute maintains a circulation of 80,000 cubic feet of air. In the other case the same type and size of fan, driven at a speed of 60 revolutions per minute, is yielding only 40,000 cubic feet of air per minute. This comparison seems to indicate that the one fan is doing vastly better work than the other, and these men are at a loss to explain the cause. The superintendent whose fan is giving the better results promises, at an early date, to go over to his neighbor's mine and ascertain if he can, the cause of the trouble. He goes, but after a careful investigation of the fan and its surroundings, and of the airways of the mine, he can find nothing to criticize, and indeed the condition of the entire mine appears to surpass that of his own. The help that he gives his neighbor in the matter of fan ventilation is like that which one blind man gives to another.

The rule referred to above as often given to express the relation between the speed of a fan and its yield, would seem to indicate that any change in the speed of a fan would result in a corresponding change in its yield. The statement of the rule, allowing, for the present, that this relationship is the true relation that exists between the speed and yield of a fan, is not sufficiently guarded as to the statement of the conditions that accomplish this result. To make the matter clear let us suppose a fan running at a speed of 50 revolutions per minute circulates 40,000 cubic feet of air in a given mine; and suppose we desire this circulation increased to 80,000 cubic feet of air. There are two ways in which this may be accomplished, assuming that the volume, 80,000 cubic feet of air per minute, is not beyond the fan's capacity. First, by increasing the power applied to the fan-shaft, the speed of the fan is increased to, say 100 revolutions per minute, and the volume of air in circulation is thereby likewise increased to approximately 80,000 cubic feet. In this case the yield of the fan is approximately in accordance with the rule stated above. We observe the increase of speed and the resulting increase in the circulation have been obtained by an increase of power. Second, the same increase in circulation may be accomplished without any increase of power, by changing the conditions in the mine. For example, if the air current be divided into two equal splits, at the foot of the downcast shaft, disregarding the resistance of the

fan and shafts the quantity of air in circulation in the mine may be assumed as doubled without increasing the power applied to the fan-shaft. The effect upon the fan will be found in practice to lower its speed slightly, and this result therefore, does not show conformity to the rule, which only applies when the increase of quantity is accomplished by increasing the power. However, as we have often stated before, the quantity, even in this case when increasing the power, does not increase in the same ratio as the speed of the fan but falls short of it. This is due to the disproportionate absorption of power in the fan and the airways, the fan always absorbing more than its proportion of the power as the latter is increased. The ratio between the speed and the yield seems to be as the fourth power of the speed to the fifth power of the yield, or as $\frac{n^4}{q^5}$, and q varies as the $\sqrt[5]{n^4}$.

Perhaps in no other branch of science are there conditions so variable or so dependent upon each other as we find them in mine ventilation. A change of temperature or even the loss of ventilating pressure in passing from the intake to the return airway, produces a change in quantity. Assuming the sectional area of the return airway to be equal to that of the intake, the velocity of the return current from these causes alone (the latter contributes only slightly, and may generally be ignored) is greater than that of the intake; and these considerations show that the velocity, pressure, and temperature should always be observed at the same point in an airway, and this point should be chosen as near as possible to the ventilator, but sufficiently removed from it to ensure a uniform velocity and pressure. The point chosen for making these observations should not be near to a bend or curve in the air course, for the reason that the air current will always follow the outer curve where the direction of the airway changes.

The neglect to observe and study conditions has resulted in tabulating and recording a large number of contradictory results, and these perhaps, more than anything else, have led to the present confusion of ideas among different authors, in mine ventilation. It is not so much a difference in theory or in fundamental laws and principles that underlie ventilation; but purely and simply a neglect to observe conditions common to mining; or, in some cases, ignorance of those conditions.

The study of mine ventilation should be treated as any other study of the mechanics of fluids. We often fail to discern the elements of the problem. The application of a given power or of a given pressure against a given resistance produces a certain velocity. This is the basis of all mine ventilation. Quantity is the result of velocity produced in an airway of a given sectional area. One of the basal equations of ventilation is the expression for power (work per minute) in terms of the resistance (ksv^3) and the velocity v . Thus $u = ksv^3 \times v$, which may be written

$v = \frac{u}{ksv^3}$. In other words the velocity in the airway is always equal to the ratio between the power applied to the airway and the resistance; these are simple elements. Again, writing for v in the above expression for work, its value $\frac{Q}{a}$, we obtain, $u = \frac{ks}{a^3} \times Q^3$.

The expression $\frac{ks}{a^3}$ contains all the factors of the airway or mine, the unit resistance (k), rubbing surface (s), and area (a); and we may represent this expression by $\frac{1}{X^3}$ and call it the mine potential.

We see below that this mine potential ($X = \frac{a}{\sqrt[3]{ks}}$) expresses the ratio that always exists between the quantity of air in circulation, and the cube root of the power producing the circulation. The expression for power then, in terms of the quantity and of the mine or airway, is $u = \frac{Q^3}{X^3}$, from which we may write, $X = \frac{Q}{\sqrt[3]{u}}$.

This expression of the potential we call the potential of the circulation, because it is expressed in terms of the quantity and the power of any circulation. Elementary equations such as these, expressing the simple ratios that thus exist between power, resistance, and velocity, or between the power producing circulation, the quantity of a circulation, and the airway in which such circulation is maintained, should form the basis of our calculations and investigations.

Air-Crossings or Air-Bridges.

The efficient and economical ventilation of a mine requires that as each pair of cross entries reaches a certain stage of development, an air-crossing or air-bridge should be erected at their mouth for the purpose of providing a separate current for the ventilation of those entries. By this means pure air from the main intake airway is supplied to each pair of cross entries. Fig. 1 represents a plan of a small portion of a mine in a flat seam

where the cross entries are turned off to each side of the main roadways. The figure shows the arrangement of the haulage roads and the position of the air-bridges built over or under the roadways. The roads are necessarily maintained at the level of the floor of the mine, and the air-crossings are conducted over or under them. The plan shows the haulage upon the return airways; but the position of the two bridges would be the same if the current were reversed and the haulage roads made the intake airways. It will be observed that the only doors required in this system are the doors shown at *a* and *b*, making one door for each pair of cross entries, dividing the back entries *cc* from the main roadways *dd*. The main haulage roads of the mine are left unobstructed from the face to the bottom of the shaft, as shown by the tracks in the main entry *e* and the cross entries *dd*.

There are several forms of air-bridges, which may either overcast or undercast the haulage road. These may be constructed by building a simple bridge in the roof or the floor of the main haulway to divide it from the entry crossing the main entry; or the air-crossing may be formed by driving the cross entry in the solid roof strata or in the strata underlying the haulway. All of these methods of constructing bridges have their defects, and each possesses its own advantages and disadvantages.

Undercasts.—This form of air-crossing was formerly more prevalent than at the present time, but owing to the serious troubles to which it gives rise it has gradually fallen into disuse. The most serious objection perhaps to this form of construction is the lodgement that it provides for the accumulation of water and blackdamp. In case of an accident in the mine, the passageway is often found to be impassable on account of being flooded with water. The accumulation of water also decreases the efficiency of the passage for ventilating purposes. Another serious objection is that when haulage is performed upon the return airway and the intake air is undercast, the air is often rendered impure and unwholesome by the sifting of fine dust through the floor of the bridge. The bridge cannot be kept air-tight as readily as an overcast bridge, on account of the constant passage of cars and men over it.

Overcast.—This is the prevalent form of air-bridge, and perhaps possesses more points in its favor than either of the other forms. The bridge is easily constructed and maintained in an air-tight condition. There is no lodgment for water, and the lighter gases that tend to accumulate above the bridge are more easily removed by the ventilating current than the heavy damps that accumulate in an undercast. An intake current of air passing over the bridge is not contaminated with dust from the roadways as in the case of the undercast.

In the comparison of air-crossings built either as undercasts or overcasts by constructing a simple floor dividing the two airways, and those that are excavated in the solid strata below or above the main roadway, there will be found defects in each system. The chief point of difference between the two systems is in the relief that is afforded by the light flooring when an explosion takes place in one or the other of the airways crossing each other. It is argued by many that it is better to maintain the intake and return airways as separate from each other as possible, by driving the cross airway through the solid roof strata. In support of this opinion it has been claimed that there is always greater violence manifested at the bridge than at any other point in the mine. On the other hand, there are found possibly more who argue in favor of the timber floorway dividing the two airways, claiming that relief is given to the force of an explosion by the destruction of the bridge at this point, and the

explosion will not therefore extend as far in the airway as it would otherwise. However this may be, it is an indisputable fact that the air-crossing driven in the solid strata, and which is not destroyed by the force of an explosion, does not result in the impairing of the ventilation, nor require to be repaired after an explosion, before ventilation can be restored. This is an important point in the ventilation of gaseous mines, and undoubtedly would lead us to decide in favor of the crossing in solid strata, notwithstanding the increased expense of its construction, which is the chief argument against its adoption.

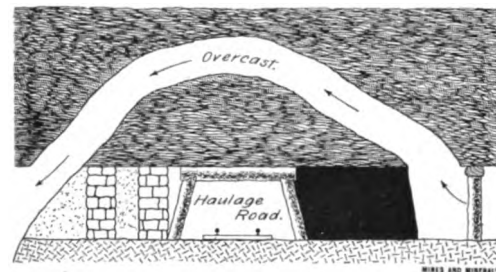


FIG. 4.

Where the timber floor is used to divide the two airways, the crossing is constructed by first blowing down the roof (overcast), or excavating the floor (undercast) of the main roadway to a height or depth equal to that of the roadway. This excavation is then extended to the right and the left of the roadway through the solid strata to connect with the entries upon either side; heavy timbers are laid upon each side of this excavation to support the bridge. It is a good plan in building this form of air-bridge to provide in it a trap door that will rise and fall under the pressure of a heavy blast. This may prevent its destruction in case of an explosion, as the heaviest timbers cannot be relied upon to resist the hurricane force of an explosion. The writer has seen an air-bridge of timbers torn to pieces by the force of a comparatively small explosion. After the bridge is laid it is carefully calked or stopped with clay. When the air-crossing is made by driving through the solid strata an upraise is started in the roof of the cross entry at a point sufficiently far back from the main roadway. These several forms of air-crossings are shown in Figs. 2, 3, and 4. These cuts have been drawn with particular reference to the manner of timbering and framing an air-crossing. In Fig. 2, the airway is open on each side of the haulage road, which is closed by heavy plank stoppings. This bridge cannot be maintained air-tight.

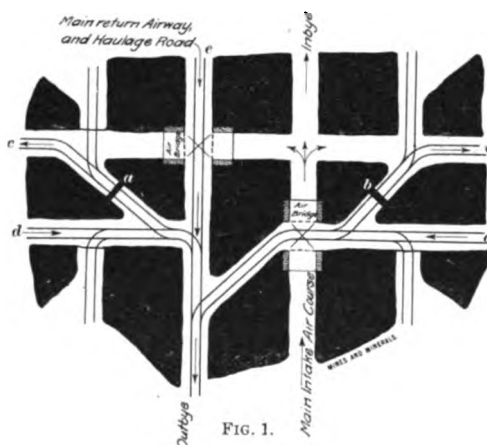


FIG. 1.

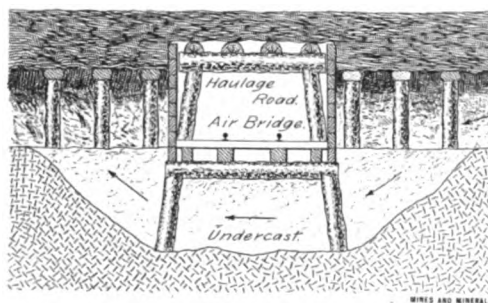


FIG. 2.

In Figs. 3 and 4, the airway is only open on one side of the haulage road, a solid rib of coal forming the other side. The building on the left in Fig. 3, forming the approach to the overcast is constructed of the roof strata excavated to form the passage. It is laid in sand or dust from the roadway to make it air-tight and is faced with clay. Fig. 4 shows a double stopping.

Steam Shovel Record.

In the November issue of MINES AND MINERALS in an article upon the Mesaba country, p. 151, the maximum steam shovel record was given as 171—26 ton cars or 4,446 tons in ten hours. We are informed that the record was surpassed by a Vulcan shovel as is shown by the following letter addressed to the Vulcan Iron Works Company, Toledo, Ohio, by Mr. J. D. Gilchrist, Supt. of the Oliver Mining Co.:

"Regarding the 'Giant A' steam shovel built by the Vulcan Iron Works Company last year for the Mountain Iron Mine, would say that beginning June 1st we loaded six hundred thousand tons in less than four months actual time. This was done without crowding the shovel, excepting two days when an effort was being made to determine its capacity. The result of the last trial was two hundred and thirty-two cars or fifty-eight hundred and twenty-five tons in nine hours. There was very little expense or time lost on account of repairs. For a shovel of its size and for the work we have for it, do not think there is anything better."

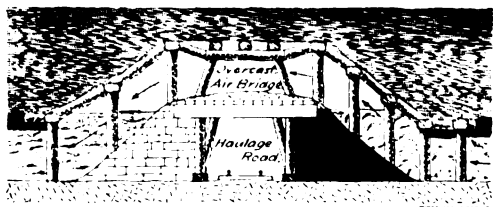


FIG. 3.

MINING WRINKLES.

For original contributions upon mining or metallurgical topics descriptive of new and handy devices and appliances we will pay at the rate of five dollars (\$5) per column, payment to be in technical or scientific books to be chosen by the contributor.

Cheap Stoppings for Mines.

Written for MINES AND MINERALS, by James Hart, Trotter, Pa.

Being confronted with the necessity of building a considerable number of masonry stoppings, in the construction of a new airway, and as some of them were in isolated portions of our mine at a considerable distance from any line of track, the question of cost of erection troubled me for quite a while. As the transportation of material for the building of masonry stoppings, especially when they are situated as some of those were, away from any line of track, is a large factor in the cost of erection of masonry stoppings, and as the cost of labor and material were equally high I determined upon trying the following method:

In the neighborhood of the first stopping I was going to have erected, there was considerable hard horseback which I had broken into rubble. Slits were then cut into the rib sides where the stopping was to be erected, as for an ordinary masonry stopping, four posts of old wooden rails were stood up on each side of the slits in the rib, equidistant from each other and the sides of entry. These rows of posts were two feet apart. Two twelve inch hemlock boards were then put on inside of the posts flush with the rib sides, making a trough two feet wide and across from side to side of the entry; into this trough six inches of rubble was shoveled, using a coke fork instead of shovel so as to avoid any dead black or small being shoveled into trough, a mortar box had been previously made in the vicinity of stopping, and common cement and sand in the proportion of one to two was mixed thin in the mortar box and poured on top of the rubble with buckets until all the crevices were completely filled; then six inches more of rubble were forked in and cement poured on as before. This was continued until the top was reached by adding boards to the inside as they were required. When it was impossible to pour cement on account of proximity of the top, the rubble and cement were mixed together in the mortar box and shoveled into the top, and finished with trowels. After standing one day the posts were taken down and the boards taken off, then the stopping was plastered; very little plastering was required as the cement had run down the face of the boards, making a clean surface.

Crevices that were at the juncture of the end of the boards and rib sides were stuffed with old waste and cement sacks, so as to avoid the leaking of the cement, the boards and posts were then taken to be used in the erection of the next stopping.

In the neighborhood of the next stopping I was going to erect there was no horseback convenient and very little draw slate, I therefore had coal taken off rib side and broken into rubble, mixing it with the draw slate and using it as in the former stopping, this stopping was only fifteen inches thick.

Those stoppings have now been erected four weeks, and are perfectly air tight and are as solid and more firm than any stopping built of stone or brick of the same dimensions.

This last stopping which was seventy feet area and fifteen inches thick required three barrels of cement and six barrels of sand to build it. I am proceeding to build my other one with the most available material in the vicinity for its construction.

This method besides saving the cost of material and labor, may be an advantage to mining as it is a well known fact that on account of the expense of masonry stoppings, wooden ones are often adhered to on important airways or base subterfuges for masonry substituted.

When slate or horseback is not obtainable, coal if hard, can be used, as it being encased in cement, and the fronts being plastered eliminates any danger from erosion or disintegration that might otherwise occur.

Marking Roof Stations in Mine Surveying.

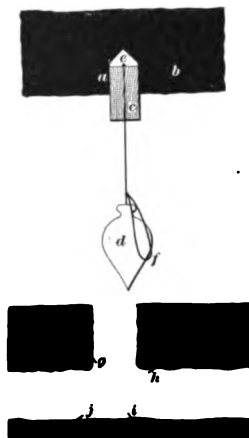
By W. W. Core, Scranton, Pa.

In some mines, the surveyor, for the purpose of marking sight centers, or stations, drills a hole in the top and then drives a wooden plug into the hole and a nail with a hole in its head into the plug, so that he can quickly hang and remove the plumb line when running up the centers with the transit. I tried this way, and when I went to look for the plugs again I more often found the empty hole, the plugs, either having been burnt out, or pulled out, by the mischievous trapper boy.

I very soon became tired of putting in new plugs and besides was not always certain that the nail had been in the center of the

old plug, and therefore, was not sure of the accuracy of my new run, until I first tested the accuracy of this newly placed nail. This led me to devise the plan shown in the figure. I drilled a $\frac{1}{2}$ -inch hole a in the top b and hung the plumb bob, by drilling a small hole in the exact center of a plug c , which fitted the hole tightly, with a very slight taper but which could be easily taken out and carried from station to station. The string of the bob d was put through the hole and a knot tied as shown at e . The height of the plumb was adjusted by means of a slip-knot in the string, which was made near the plumb itself and tied in such a manner, that when the loop f was made longer it took up, and therefore shortened the cord above it and not that below. This way of adjusting the length of the line proved very satisfactory, for all practical purposes, but I think that a plumb with a cord adjusting contrivance, that is of good practical design, would be an improvement. There are several makes of these line adjusting plumbs on the market, some of which are very good.

It can readily be seen that the hole is hard for the boys to destroy without considerable effort, but in one place on the main entry, where a number of boys used to gather, and do as much mischief as they could think of, I was afraid that even the hole might be molested, and so located it by cutting four lines in the sandstone top with a pointer, as at g, h, i, j , Fig. 2. It proved well that I did so, for I went to look for the station one night and found that the boys had pulled down a large piece of the top, in which the "center" had been located. This did not bother me so much though, for I stretched two lines, one from g to i and the other from h to j , and where they crossed I put up a new center, which of course was in the same vertical line as the old one had been. If I had been taking the level of the station into account, it would have been very easy to take its distance above the rail as a vertical location.



An Improved Rock Drill Fastening.

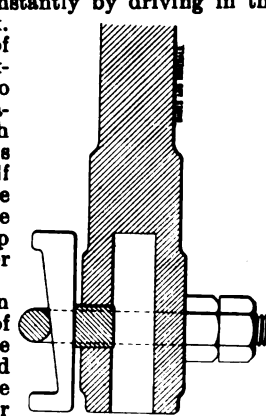
By Geo. W. Ritter, Eureka, Utah.

Every one using rock drills will be interested in a simple contrivance which saves a large portion of the labor ordinarily consumed in removing and substituting drill bits.

In nearly all of the rock drills in use, the bit is clamped in the piston bushing or chuck by means of a gib and a U bolt; by tightening the nuts of the U bolt, the gib is drawn inward, giving a firm grip on the shank of the bit. Bits, however, have to be changed many times in the course of a day's work, and with each change the process of loosening and tightening these nuts must be gone through with. Very often the manipulator is obliged to handle a wrench in a close awkward corner. All of this takes time, labor, and patience, to say nothing about the wear and tear on tools and U bolts.

The innovation referred to in this article consists of a taper key or wedge which is inserted between the U bolt and the gib, so that the chuck can be tightened instantly by driving in the wedge, or loosened by driving it back. An excellent key may be forged out of a piece of tool steel, being made approximately four inches long, about two inches in width according to the machine to which it is to be applied, with thickness tapering from three-fourths of an inch at the large end to one-half inch at the small end. It should have a shoulder at each end to facilitate driving it back and forth, and to keep it from being driven out from under the U bolt.

The key is inserted with the thin end towards the front, and the nuts of the U bolt are then screwed up to the proper point once for all. The forward stroke of the piston serves to keep the key in place perfectly tight. In order to prevent the nuts from coming loose the threads of the U bolt may be riveted or flattened. Some operators prefer to apply a jam nut; in this case, however, the nuts should be thin, because with the size ordinarily found on U bolts an extra nut would protrude far enough to strike the shell of the machine during the early portion of the feed.



Simplicity, cheapness, effectiveness, and adaptability are all points of merit possessed by the device. It can be made in any blacksmith shop; it can be readily applied to any rock drill in use. In operation, a few taps with a hammer or any convenient substitute does away with all the turning and twisting and tugging involved in loosening and tightening nuts with a wrench. Fewer U bolts are destroyed than formerly. The time saved in changing bits can be employed in drilling more holes or deeper ones; this means better headway in the prosecution of work and less ultimate cost. This contrivance is not entirely new and is not patented. It has found its way into a few mines in California and elsewhere in the West, and wherever adopted has given extremely satisfactory results.

Crane Company at the Paris Exposition.

One of the exhibits at the Exposition Universelle, Paris, which attracted wide attention was that of Crane Co., probably the largest manufacturers of valves and fittings in the world, the head offices and factories of which are located in Chicago.

provinces of Persia which border on the Persian Gulf. He now describes the results of his investigation. He proceeded in the first instance to Bushir, on the Persian Gulf, and observes that the climate is so hot and enervating that ordinary European labor would be incapable of utilization, and that native labor would have to be employed in any mining undertakings in this region. Such labor is altogether unskilled. Other difficulties lie in the absence of roads, in the great distances inhabited places are apart, and in the general absence of water. This latter in particular renders prospecting a matter of much difficulty. During two and a half years the author prospected throughout the provinces of Ghermsir, Farsistan, Charistan, Kerman, Yezd, Beludshishan, etc., as well as islands in the Persian Gulf, the whole district being of about the size of Hungary. He deals generally with the various mineral deposits, and some of these are referred to under their respective headings in these abstracts. Minerals other than those so dealt with are, however, also mentioned.

Southern Persia consists mainly of limestone. The limestone ranges reach heights exceeding 13,000 feet. There are very few

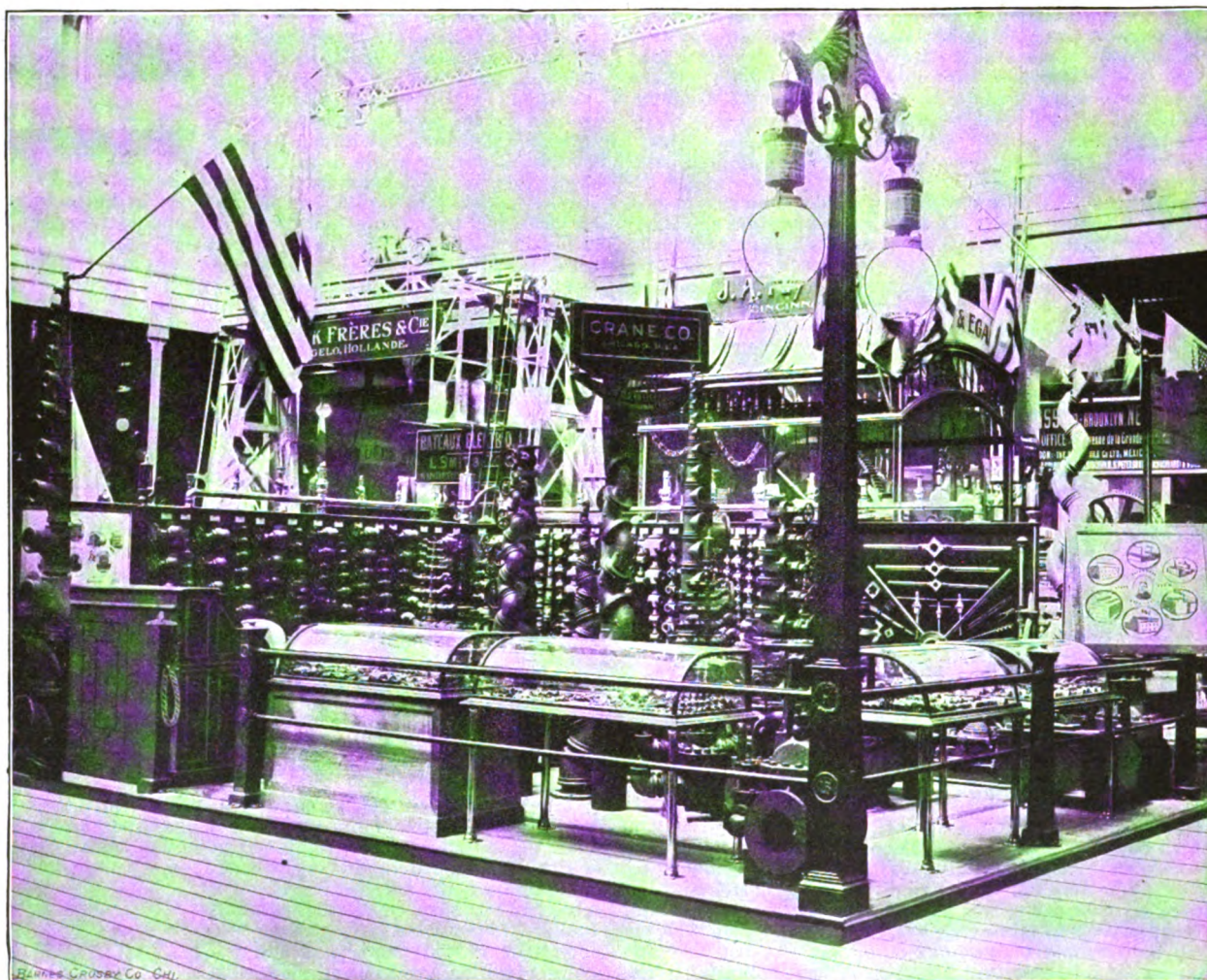


EXHIBIT OF CRANE CO. AT THE PARIS EXPOSITION.

This exhibit occupied a desirable position in the Palace of Machinery & Electricity, Champs de Mars, and consisted of brass and iron valves and cocks for all pressures, brass and iron fittings, steam specialties, engineers' supplies, and steam and gas fitters' tools.

Crane Co. was the only exhibitor of this class of goods to receive a gold medal. The exhibit was tastefully arranged, as will be seen from the accompanying photograph, and gave an especially good opportunity to visitors to study approved modern methods of piping, flanged work, etc. for power plants—a branch of the business of this company which has become very important.

Mineral Resources of Persia.

H. Winklehner observes that early in the nineties an English company was granted the sole right of mining in Persia, except for the precious metals and precious stones, and that he was appointed by this company to prospect for minerals those

fossil remains, but the geological age is undoubtedly mainly Cretaceous. Basalt and trachyte burst through the chalk in places, and formations more recent than Cretaceous are also occasionally met with. The author is of opinion that under existing conditions a mining undertaking in Persia would be hopeless. Eighty per cent. of the country is sandy desert or bare mountains; it is very thinly populated, and there is not a single decent road in the whole of Persia, except one between Teheran and Kaswin, which is in very bad repair, and another from Teheran to Kum and Kashan. Were coal and petroleum to exist in the neighborhood of the Persian Gulf, they would be of importance, but there are no deposits of the former, and those of the latter are not likely to be developed yet awhile. Wood and water are so scarce, that metal mining would have great difficulties to contend against. Adequate transport facilities must first exist before there is any hope, the author thinks, of possible progress for the mining industry of Persia.

NEW INVENTIONS.

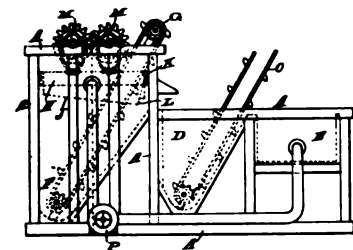
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

Single copies.....	5 cents each.
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An entire set of patents.....	1 cent each.

COAL WASHER.

No. 657,184. E. A. STEWART, CINCINNATI, O. *Patented Sept. 4, 1900.* The washer covered by this patent is shown by the accompanying figure. The coal is fed into a jig box *H* in a tank in the upper portion of the machine. This jig has a screen *J* in the bottom and is given a vertical reciprocating motion by means of the eccentrics *MM*. The entire apparatus is supported in a framework *A*. There are two discharge openings from the jig *H*, the lower one *L* serving for the slate or refuse and the upper one, *K*, for the washed or clean coal. The slate or refuse descends into the pocket *F* from which it is removed by the bucket elevator *G*, while the washed coal passes into the

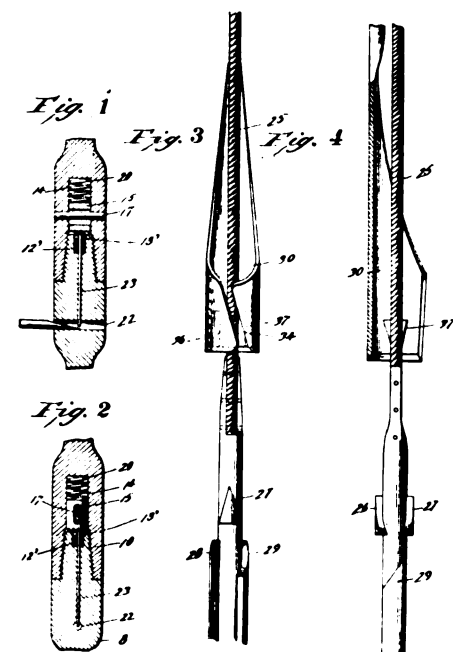


chamber *D* from which it is removed by the bucket elevator *O*. The superfluous water collects in the tank *E* and is returned to the jig by the centrifugal pump *P*. The jig frame *H* is made a fairly close fit in the compartment in which it operates. The jig compartment is separate from a narrow compartment into which the centrifugal pump discharges its water, the water passing through a small opening in this partition below the screen of the jig, but this opening is provided with a valve which automatically closes during the descent of the jig and opens during its ascent, thus rendering the action of the water in the jig compartment more effective.

DRILL JAR AND COUPLING.

No. 657,205. T. SEEVERS, OSKALOOSA, IOWA. *Patented Sept. 14, 1900.* This patent is intended to cover two points, first a special means of uniting the drill to the drill rods, or the drill rods to each other, and second a specially devised set of jars for loosening the drill when it becomes stuck in the hole. The coupling for the rods is illustrated in Figs. 1 and 2. The rods are coupled by the ordinary tapered male and

female thread joint, but in the upper portion a recess *14* has been formed in which a toothed collar *15* is placed. The upper end of the male portion of the screw *10* is toothed or serrated to match the collar *15*. The collar is held in place by a spring *20* and when in contact with the upper end of the screw prevents any tendency for the screw to back out and thus loosen the joint. The collar *15* is held from rotating by a pin *17* passing through a slot in the collar. In order to enable the operator to unscrew the rods when he wishes, a pin *23* is placed through the center of the male portion of the screw and so arranged that it can be raised by driving a key through the hole *22*. The raising of this pin forces the collar up into the position shown in Fig. 1, thus disengaging the

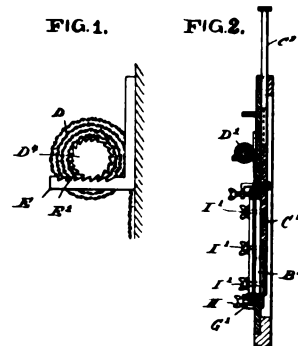


teeth and allowing the rods to be unscrewed. A special packing gland *13* and packing *12* is provided about the rod *25* to prevent water and sand from ascending from the hole *22* into the space occupied by the collar *15*. The jar covered by this patent is illustrated in Figs. 3 and 4. It consists of a piece *30* so formed that it will surround the drilling rope *25* and can be passed over the drilling rope by means of the diagonal slot *34*, it being necessary to incline the jar at an angle to the rope when passing over, the jar always being in an erect position

in the hole will have no tendency to detach itself from around the rope. Near the lower end of the jar there are arranged two lugs *36* and *37* and at the upper end of the drill rods two similar lugs *26* and *27*. Just below the lugs on the drill rods there are two pieces *28* and *29*. The lugs *26* and *27* each occupy a little less than 90° of the surface of the rod and the same is true of the pieces *28* and *29*, but the pieces *28* and *29* are so arranged that as the jar descends the lugs *36* and *37* pass between the lugs *26* and *27*, after which the jars are given a quarter rotation by the beveled upper surface of the pieces *28* and *29*, the lugs *36* and *37* passing into the space between the pieces *28* and *29*. After this, if the jars are given a sudden upward motion the lugs *36* and *37* will come up under the lugs *26* and *27* and by continuing this action the bit may be jarred loose. When it is desired to remove the jars from the hole the rope carrying them is twisted as they are slowly raised. This will cause the lugs *36* and *37* to pass out from under the lugs *26* and *27* up between them so that the jars can be removed from the hole.

SCREEN FOR STAMP MILLS.

No. 656,098. M. R. DRISCOLL, FRISCO, UTAH. *Patented, Aug. 14, 1900.* In ordinary stamp mill practice the lower portion of the screens usually wears out sooner than the upper, and the whole screen has to be replaced. The present invention provides a means for replacing the screen or the lower portion of it immediately and consists in the placing of a roll of screen cloth *D* above the opening in the front of the battery and securing the screen by a framework *G'* and bolts *H* and *I'*. When the lower portion of the screen wears, the door or slide *C'* can be dropped down inside of the screen thus temporarily stopping the feed of pulp through this screen, the clamp bolts and clamping frame removed, the lower or damaged portion of the screen cut off and more screen drawn down to cover the opening, and clamped once more. In the accompanying illustrations Fig. 2 shows a section through the front of the mortar

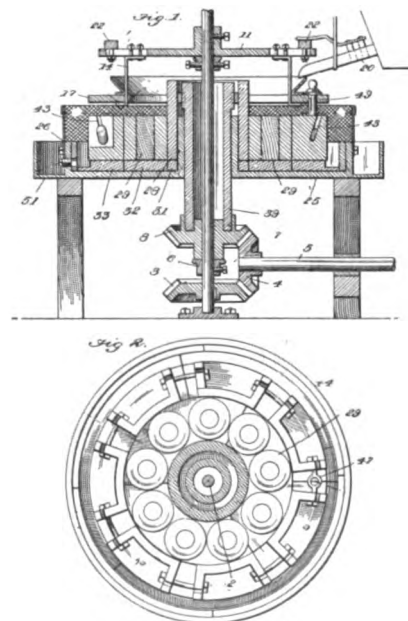


showing the screen in place and the gate *C'* intended for closing the opening *B'* whenever it is desired to change screens. By this means screens can be changed without stopping the work. Fig. 1 shows a method of securing the roll. The roll shaft or its ends are notched as shown at *D'* in the illustration and rest in the bracket *E* having teeth *E'*. These teeth prevent the screen from feeding down when a pressure is brought upon it by the heavy swash of the pulp against the lower portion of the screen and at the same time enable the operator to always keep the roll of screen cloth pressed back against the face of the battery no matter what size the roll may be.

QUARTZ MILL.

No. 655,793. A. T. MACMURTRY, MEDFORD, ORE. *Patented, Aug. 14, 1900.* The general arrangement of this mill is illustrated in Figs. 1 and 2. It consists of a pan *25* in which the grinding is carried on.

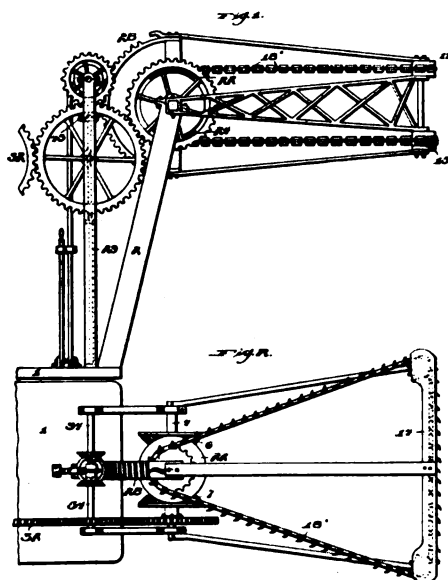
The grinding is carried on by three sets of grinding members, two of which are driven in opposite directions. To accomplish this the vertical shaft has the bevel gear *3* attached to its lower edge, this bevel gear being in contact with the lower edge of the bevel gear *4* on the shaft *5*. Upon the shaft *2* there is an adjustable collar *6* which supports the bevel gear *8*, this gear being loose upon the vertical shaft and engaging with the upper edge of the gear *4*. The result is that the bevel gears *3* and *8* are driven in opposite directions. The bevel gear *8* drives the sleeve *39* which operates the crushing ring *28*. Under the crushing ring *28* are placed dies *31*. The shaft *2* operates the spider *11*. This spider carries cams *22* which control the feed of the ore by jarring or shaking the spout *20*. The spider *11* also carries arms *14* which support the ring *17* carrying the feed hopper. The pin *49* connects the ring *17* with the outer mullers *43* by engaging the special bolt *47*, as shown in Fig. 2. Between the mullers *43* and the grinding ring *28* are situated a series of rollers *29*. These rollers may be either solid or they may be hollow with a plug of hard wood fitted into them as shown in Fig. 1. The material is crushed between the rollers *29*, the mullers *43* and the grinding ring *28*. The bottom of the pan is provided



with dies 32 under the rollers 29, and 33 under the mullers 43. The fine material passes through between or under the mullers and is finally discharged through the screen 26 into the annular trough 51. The inventor states that this machine may be used as an amalgamator by replacing the screen 26 by a solid pan or ring.

MINING MACHINE.

No. 659,984. E. O'TOOLE, LEISENRING, PA. *Patented Oct. 16, 1900.* The machine covered by this patent differs from the ordinary type of



undercutting machine in that it is arranged to remove all of the material mechanically. It consists of a base 1 upon which are mounted inclined columns 2 and the vertical columns 29. The inclined columns support the shaft 4 carrying bevel gears 6 and 7. These bevel gears operate other bevel gears 22 and 24 which drive the two chains 18 in opposite directions. These chains are provided with cutters as shown. The path of the chain is a triangle, the cutting being done along the side furthest from the driving mechanism and upon this side the chain runs in slots in the bars 14 and 15 so arranged that only the cutters project from the

PROCESS OF EXTRACTING ZINC AND COPPER FROM THEIR ORES.

No. 659,338. C. G. COLLINS, NEW YORK. *Patented Oct. 9, 1900.* This patent covers the use of a solvent composed of what is commonly called niter-cake, or the material resulting from the manufacture of nitric acid. The inventor describes this as being composed of approximately sulphate of sodium 75.8 per cent., sulphuric acid 16.68 per cent., water 6 per cent., insoluble matter 1.52 per cent. He states that the solution may be varied, but that a 5 per cent. Baume scale is usually the best, on account of the fact that it exercises a selective action for the copper and zinc without attacking the iron or aluminum to so great an extent. The metals may be recovered electrolytically or precipitated by chemical means. The roasted or unroasted ore, as its condition requires, is treated with the solution.

PROCESS OF EXTRACTING COPPER AND ZINC FROM THEIR ORES.

No. 659,339. C. G. COLLINS, NEW YORK. *Patented Oct. 9, 1900.* The process covered by this invention proposes to use salt-cake, or the material left from the manufacture of hydrochloric acid. This material is said to be composed of about as follows: Sulphate of soda, 95 per cent., chloride of sodium, 2 per cent., sulphuric acid 2 per cent., magnesium, 1 per cent. As in the previous patent, it is claimed that the strength of the solution may be varied, but that a 5 per cent. Baume solution has been found best, on account of the fact that it exercises a selective action for the metals desired. The roasted or unroasted ore, as its condition requires, is treated with the solution. It is said that the metals may be deposited electrolytically or precipitated chemically.

PROCESS FOR EXTRACTION OF ZINC AND COPPER FROM ORES.

No. 659,340. C. G. COLLINS, NEW YORK. *Patented Oct. 9, 1900.* This patent covers the use of a solution containing both salt-cake and niter-cake. The patentee states that the strength of the solution may be varied, but that he has found that the saturated solution is the best for general use, though if the ore carries iron or aluminum or other soluble substances in large quantities a weaker solution may be used, as for instance a 5 per cent. Baume solution. As in the previous processes the crushed ore, roasted or unroasted, as may be necessary, is treated with the solution and the metals recovered electrolytically or by chemical precipitation.

METHOD OF EXTRACTING GOLD FROM CYANIDE SOLUTIONS CONTAINING THE PRECIOUS METALS.

No. 654,437. W. A. CALDECOTT, JOHANNESBURG, S. A. R. *Patented July 24, 1900.* The gold-bearing solution of potassium cyanide of any strength is passed through launders or boxes containing a mechanical mixture of zinc shavings and lead shavings and the gold is allowed to deposit on the mixture of metals. The gold is then obtained in the usual way. The advantages of a mechanical mixture of lead shavings and zinc shavings over old forms of lead-zinc couples is as follows: In precipitating the gold from gold-bearing cyanide solution obtained in the treatment of auriferous battery-slimes these solutions frequently carry finely-divided solid matter in suspension. This suspended solid matter becomes deposited all over the surface of the precipitating agent, forming a slimy coating, and thereby protecting it to a great extent from actual contact with the solution, thus gradually lessening its efficiency. In the case of lead-zinc alloys or of a lead-zinc couple formed by lead deposited on zinc, fresh solution is not allowed to pass between the zinc and lead particles after the formation of this coating and to thereby become subjected to the action of the galvanic current, which causes the precipitation of the gold. In the case, however, of a mechanical mixture of lead and zinc shavings actual experience on a large scale has shown that although the zinc shavings and lead shavings become coated in the manner described, yet there being an appreciable interval between the shavings through which a stream of solution is constantly passing the galvanic current still acts, and passing from the zinc to the lead, causes the precipitation of the gold. In other words, the mechanical mixture of zinc shavings and lead shavings retains its efficiency for the reasons above described longer than other lead-zinc couples in precipitating the gold from the turbid cyanide solutions met with in certain operations of gold extraction, particularly in the treatment of slimes. Preferably the mixture of lead and zinc shavings is formed as follows: Alternate layers of zinc, lead, and paper are made up on a mandrel, forming a compact cylinder, and from this lead and zinc shavings are produced simultaneously as one shaving, the paper giving a division-line between the alternate layers of lead and zinc. The lead and zinc thus form an electric couple. Neither lead nor zinc by itself will decompose water and precipitate gold from a solution in which there is no cyanide, but a mixture of zinc and lead shavings will, and such use of the mixture of shavings is considered within this invention.

PATENTS ISSUED DURING OCTOBER AND NOT ILLUSTRATED.

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- Nos. 659,338, 659,339, 659,340. Process of extracting zinc and copper from their ores, C. G. Collins, New York, N. Y.
- No. 659,348. Cutting-chain for mining machines, H. H. Mercer, Claremont, N. H.
- No. 659,371. Machine for sharpening rock-drills, W. E. Kimber, Johannesburg, South African Republic.
- No. 659,502. Movable coal or ore handling and storage device, R. D. White, P. S. Hildredth, and A. Liehmann, New York, N. Y.
- No. 658,807. Mechanism for sizing and segregating ores or disintegrating materials, C. E. Seymour and H. S. Morey, Placerville, Cal.
- No. 658,813. Washer and concentrator for ores, etc., H. T. Spring, and C. A. Spring, Philadelphia, Pa.
- No. 658,921. Ore-separator, J. B. Moore, Oakland, Cal.
- No. 658,938. Process of extracting gold, silver, etc., from ores, J. B. De Alzugaray, London, Eng.
- No. 658,947. Ore-separator, W. J. Goynes, Barton Heights, and W. H. Goynes, Gowen, Pa.
- No. 659,046. Coking-oven, C. G. Atwater, Boston, Mass.
- No. 659,139. Coal or rock drill, I. Eagen, Wyoming, Pa.
- No. 659,148. Gold-separator, F. P. Hopkins and L. Manzke, Spirit Lake, Iowa.
- No. 659,185. Rock-drill, A. M. Southard, Denver, Colo.
- No. 659,670. Method of treating telluride ores, C. J. Head and R. C. Wild, London, Eng.
- No. 659,813. Ore washer and separator, E. W. Eaton, Socorro, N. Mex.
- No. 659,900. Coke-handling apparatus, J. R. Risheberger, Wooddale, Pa.
- No. 659,941. Metallurgical furnace, Wm. Swindell, Allegheny, Pa.
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- No. 660,032. Coke-loading machine, J. W. Seaver, Cleveland, O.
- No. 660,220. Fuse-igniter, J. T. Nagle, Butte, Mont.
- No. 660,342. Ore-separator, J. P. Smith, Denver, Colo.
- No. 660,409. Rock-drill, C. E. Young, Fremont, Wash.
- No. 660,451. Conveyer, G. W. McCaslin, Hoboken, N. J.
- No. 660,480. Coke-oven, E. A. Babbage, Cambria, Wyo.
- No. 660,498. Apparatus for leaching ores, J. A. Fleming, Globe, Ariz.
- No. 660,499. Apparatus for leaching ores, J. A. Fleming, Globe, Ariz.
- No. 660,724. Electric conveying and elevator apparatus, G. K. Fischer and F. Klepetko, Great Falls, Mont.
- No. 660,774. Amalgamator, T. H. Hicks, Fort Wayne, Ind.
- No. 660,844. Device for collecting finely-divided minerals and slimes, W. E. Darrow, Sonora, Cal.
- No. 660,869. Slime-jigging machine, C. B. Rogers, El Paso, Tex.
- No. 660,956. Excavating apparatus, Wm. Henderson, Washington, D. C.
- No. 660,982. Hearth for roasting ores, G. Clary, Zacatecas, Mex.

Mines and Minerals

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THE AMERICAN NETTIE.

A Mine Furnishing an Illustration of the Peculiar Cave Deposits
and the Method of Mining Them Near Ouray, Colorado.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The mining town of Ouray is located in a pit-like depression in the San Juan Mountains. It is surrounded on all sides by lofty and precipitous mountains with steep cliffs. At the south end these mountains are composed on top of a massive formation of andesitic breccia for over a thousand feet in thickness. This rests upon upturned Algonkian schists and quartzites and more horizontal Paleozoic strata. The breccia carved into rugged and castellated forms of delicate lavender-gray color give pleasing background to the city.

The southern portion of the depression is of massive beds of red Jurassic conglomerate capped by softer beds of shales and sandstones of the Jurassic and Lower Cretaceous with some hundred feet or more of the dark shales of the Marine Cretaceous. These are capped in turn by intrusive sheets of porphyrite and by a body of gray andesitic breccia. The whole mass is traversed from top to bottom by numerous narrow dikes of porphyrite and breccia.

In the town are several large hot springs with bath houses established over them, and the flat terrace on which the upper portion of the town is built is composed of thick layers of calcareous sinter or tufa deposited by ancient, but now extinct, hot-springs. In these deposits leaves and twigs of trees are imbedded.

The flat on which the town is located may at one time have been a glacial lake and enormous glacial boulders are strewn about here and there in the pretty lawns and gardens surrounding the houses.

The altitude is about 7,000 feet and the sheltered situation

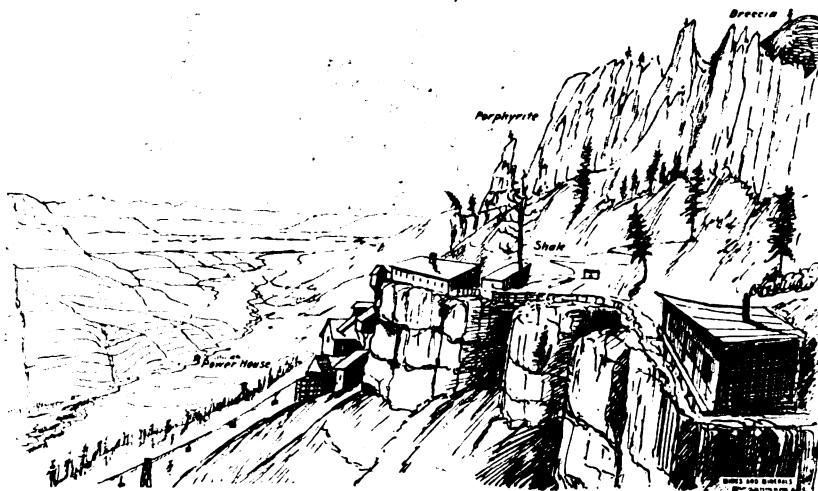
allows of the growth of gardens and fruits of various kinds. Ouray is the prettiest and most picturesque of all the mining towns of Colorado.

In the vicinity are some noted mines such as the Camp Bird, Mineral Farm, American Nettie and others. It was the last mentioned mine that was the object of our visit as one of those peculiar mines which are of exceptional interest.

The American Nettie is located in what is known locally as the Ouray gold belt, a particular zone extending for some miles, which has become noted for the number of gold-bearing mines located upon it, amongst which the American Nettie is the chief.

The gold belt or zone is found on either side of the canyon of the Uncompahgre river leading out of Ouray, the river canyon having cut the formation in half like an orange. Very similar conditions are found on both sides of the canyon.

The new mill of the American Nettie is located on the west bank of the river, and we noticed as we walked along by the side of the great cliffs of red sandstone that these cliffs showed signs of folding and faulting, dikes usually filling the fissures that are caused by the faults. About 1,000 feet of these heavy bedded red sandstones of the Trias are followed above by lighter and thinner beds of Jurassic quartzites, limestones, and altered shales for about 800 feet; then 40 feet of Dakota Cretaceous



THE AMERICAN NETTIE MINE.

quartzites in which are the ore deposits of the Nettie, and on top of which the buildings of the mine are strung along. This is capped by about 100 feet of indurated shales of the Marine Cretaceous overlaid by an intrusive sheet of porphyritic diorite or porphyrite. This again is overlaid by a heavy mass of andesitic breccia forming the summit of the mountain. Numerous narrow dikes of porphyrite and breccia cut up through these formations and unite with or cut the overlying eruptive sheets. See section, page 244.

From the mill a bucket tramway ascends from the river bed across the canyon to a height on the vertical cliff opposite of over 1,000 feet, with an unsupported span of 1,800 feet to where it meets

the first tower; then by a series of towers it ascends the remainder of its journey to the Nettie mine.

On the ground floor of the mill are 4 Wilfley tables below 20 stamps. Blake crushers receive the ore as it comes from the buckets at the receiving or lower terminal end of the bucket tramway. As the buckets enter and pass around a horizontal wheel in this station their contents are automatically dumped into the crushers. The record of the weight of each bucket, as it comes into the receiving station, is recorded by a clock with automatic-dial hand. (Shown on page 244).

The tramway ropes are firmly anchored to logs buried deep in the ground back of the building. There is a good deal of tremor caused by the tramway and stamps, which affects the balances in the assay building near by.

After examining the mill and receiving end of the tramway, in company with Mr. Ike Martin, the superintendent, we procured horses and commenced the climb of the opposite mountain to the Nettie mine by a circuitous path cut in the side of the cliff. After passing over the Jura-Trias red-beds we entered a ravine, caused by the decay of a dike of light yellow color and beds of igneous and sedimentary rocks were here reticulated with a network of tiny cracks filled with pyrite, showing the great mineralization of the area, but not in sufficient quantity or concentrated enough for working. The oxidation of this disseminated pyrite contributed some of the greenish yellow tint to the rocks.

Numerous narrow parallel dikes of greenish breccia traverse the strata composed in the lower portion of the hill of pieces of slate and above of pieces of quartzite cemented together with volcanic material. Larger dikes also occur apparently connected with the laccolitic mass of breccia and porphyrite capping the hill. The steep sides of the mountain are clothed nearly to the summit with balsam and red pine. The former makes poor mine timber but the latter is good.

Around on the edge of the timberline we found ourselves on a narrow bench partly natural and partly cut in the rock with a vertical cliff of quartzite for 40 feet below it. From the base of this a steep slope of 800 feet descends to a platform of red rocks far below, and below that again is a vertical precipice of over 1,000 feet.

Above the Dakota Cretaceous quartzite cliff rise the dark indurated Marine Cretaceous shales for about 100 feet and above them a laccolitic mass of porphyrite for another 100 feet or more, worn by erosion into sharp pinnacles, and surmounted by still another thick mass of dark grey volcanic breccia.

The first building encoun-



LARGE CAVITIES MORE OR LESS FILLED WITH VALUABLE ORE, AMERICAN NETTIE MINE.

tered on this perilous ledge is the blacksmith shop where drills were being sharpened, a small electric dynamo running the blower for the fire. Along the same shelf is the boarding house.

Below the blacksmith shop on the next ledge cut out of the rock is the ore sorting room. The ore comes into the sorting tables through a funnel-shaped hopper. The valuable material is sorted by the men, the remainder goes down a chute to the bins and to the bucket tramway. The very valuable ore is sacked and lowered down by a rope through a chute to the buckets.

On the next terrace below is the bucket tramway room and scaffolding, from this the loaded buckets automatically descend the line. The bucket comes in empty on the cable on one side of the room and passes around a horizontal wheel 8 feet in diameter till it reaches the point opposite the chute ready to fill it with ore. There by an automatic contrivance associated with a pin and a lever and brake, the ascending empty bucket automatically touches off down the tramway the one that has just been filled at the chute and takes its place, and then in like manner is touched off along its way down to a station a few hundred feet below, where if the bucket is full of waste rock a man arrests it and dumps it on the hill side, or if filled with ore, allows it to go on its way down to the mill in the valley.

Eight hundred feet below the ore house is a wide flat bench of red sandstone where is another mine only partially developed but promising well.

From the summit to the extremity of this bench where it overlooks the great fall and precipice of 1,000 feet to the valley is a line of 8 towers of wood supporting the spans of the cables. The last tower being on the edge of the precipice. From this point to the mill in the valley below is one immense unsupported span of 1,800 feet. The total length of cables is 4,100 feet. The steel ropes or cables are of three sizes, one, the pulley cable, is $\frac{3}{4}$ -inch diameter, the standing cable 1 inch, and the other $1\frac{1}{2}$ inch. The cable is coated with tar. The open scaffolding containing at one end the large horizontal wheel around which the cable revolves is 7 feet high by 50 feet long.

There are 18 buckets, 16 of which are in active use. The dimensions of the buckets are: 18 inches wide at bottom, 24 inches at top, 26 inches long, 22 inches deep. A bucket may hold from 500 to 1,000 lbs. according to the character of the material. Two men can ride in one bucket. It is a gravity tram and starts when the brakes are loosened. The average angle of inclination of the cables for the first 800 feet is about 45 degrees. The buckets are all numbered with numbers painted white on their sides.



DIKE FILLED FISSURE IN JURA-TRIAS CLIFFS BELOW AMERICAN NETTIE MINE.

From a consideration of the working of the tramway, we now turn to enter and examine the mine. But first of all we glance at the cliff of quartzite in which the ore deposits are wholly contained. This ledge of quartzite extends for some miles along the upper part of the mountains. It consists of the heavy bedded sandstones of the Dakota Cretaceous which have been metamorphosed by heat into a brown quartzite. The beds are jointed and the jointing planes are locally enlarged into small cavities on the outside. It was these cavities full of brown iron-oxide, sand, and rubbish that attracted the first prospectors. Some of these cavities were filled with the nests of the mountain rat, and it was said that at first they shipped mountain rats' nests and gravel rich in free gold to the mill. In the zone of these cavities the tunnel enters following the gentle inward dip of the strata of some five or six degrees. The tunnels are located about half way up the vertical face of the cliff. There are upwards of 5 miles of these tunnels and other workings ramifying in various directions into the rock.

The principal incline descends straight east into the mountain. This is lighted by electricity, the wires and lamps being strung along the roof. Ventilation was formerly by means of a 10 inch diameter pipe and a Baker fan-blower forcing air into the recesses of the mine. Now by communication through a shaft of 50 feet depth to an under tunnel a good draft is set up.

On either side of the tunnel we observe cavities from a few inches in diameter to others large enough for a man to crawl into. The cavities are somewhat flattened or elliptical in shape. Some are long, some short, some are quite smooth inside as if water worn, others are lined with quartz crystals, or with a coating of gouge matter. Sometimes part of the cavity is filled with oxidized ore, or in part with sulphides, or in part with quartz crystals. When the latter prevail the cavity is generally poor in the precious metals. Some cavities are quite surrounded by quartz crystals and may be empty of ore. In some the ore is brown oxide in others solid sulphide. In most cavities the ore is loose and friable, whether oxide or sulphide, and is carefully scraped out by a long iron scraper and the walls brushed with a brush. Finally a light is inserted to see if all is cleaned out. A crowbar is inserted when the ore is hard sulphide adhering to the walls. Sometimes the ore occurs more in the form of veins along shearage cracks, and may run vertically for a space along the roof of the tunnel. The narrow dikes of volcanic breccia often make ore at contact with the quartzite—though themselves containing but little ore.

Above the quartzite lies the black shale, but ore is rarely found either in the shale or at its line of contact with the quartzite, except when there is a bulge or roll of the shale down into the quartzite, when locally large bodies of ore are likely to be found.

When the quartzite is locally less metamorphosed and more like the original sandstone, the rock is apt to be barren. But when the quartzite is highly metamorphosed and semi-vitreous in character the ore abounds. Ore is found also in places at contact with a big porphyry dike cutting across the strata. From these dikes as a source, the ore seems to flow down following the dip of the strata; north and east along the zone the ore cavities and pockets are apt to diminish.

The ore zone or gold belt is many miles in lateral extent and to the far east is deeply buried below the volcanic masses of breccia, part of which is observed on top of the mountain. There are numerous mines located in the zone on both sides of the valley. Some have found big pockets of ore. Some appear to be located on breaks or faults down to the zone. Some have found only large bodies of oxidized iron ore, which for a time have proven fairly rich and then passed down into low grade sulphides. Some cavities or ore chambers are of great size, 18 feet in height by 18 to 20 feet wide and long. In mining in the Nettie, they do not generally stope upwards more than 18 or 20 feet as this brings them nearly to the contact with the overlying shale or slate. Sometimes there is a mineralized seam connecting the cavities, sometimes no visible connection at all. Zones of crushed rock from local faulting occur which are barren of ore. The dikes are sometimes shifted a few feet by local faulting and by lateral thrust to the eastward. The dikes dip steeply to the south and they seem to have been erupted in a mushy state like wet mortar, and to have gathered up fragments of the rocks they passed through.

Following down the valley of the Uncompahgre to the north the ore zone or gold belt is abruptly cut off by erosion, but may possibly be resumed again to the eastward. The country rock



OURAY, COLORADO.—STAR SHOWS LOCATION OF AMERICAN NETTIE MINE.

after this is of the Colorado shales without a cap of volcanic material.

The Nettie mine is remarkable for the great variety of minerals and ores found in it. There are copper pyrites, pea-cock copper, and iron pyrites, galena and zinc blende, gray copper and native copper with a green staining of carbonate of copper, telluride ore said to be in the form of petzite, bismuth, and green or bluish sulphate of iron called copperas, the latter resulting from secondary alteration of iron pyrites. The ore may run from \$40 to 105 ounces in gold. Pockets and cavities of moderate size have yielded 30 and 40 thousand dollars. Part of the ore is concentrating, part smelting and part free milling.

Comparatively little timber is used in the mine, the walls being very firm and solid. Very little water is encountered, the mine being generally quite dry. At present 25 men are employed at the Nettie but 100 could easily be put to work.

The view from the mine is exceedingly fine, we look across the river and see that the opposite cliffs are a counterpart of the ones we are standing on, merely separated by a deep valley of erosion. There appears to be the same red sandstones, the same capping or eruptive rocks, and the same series of narrow dikes traversing the strata from top to bottom. We notice that as the



LOWER TERMINAL OF BUCKET TRAMWAY, AMERICAN NETTIE MINE.

red strata begin to bend upward into the uplift of the range, they first fold and then fault, the fault line commonly filled by a dike.

Several good properties have been developed on the quartzite on the opposite or west side, and from these long bucket tramways descend to their mills over a thousand feet below.

Some holes or tunnels have also been opened on the line of the ascending dikes, and on the strength of a little ore first discovered in these, mills and bucket tramways were erected in the valley below. The original use of these mills having departed, owing to the ore playing out, they have either passed into decay or are utilized as general custom mills.

GEOLOGY OF THE GOLD BELT AND ORIGIN OF THE ORE DEPOSITS.

According to Mr. Kedzie, of Ouray, formerly State Geologist of Colorado, who has given great attention to this matter, there is a marked unconformability between the Carboniferous and the Jura Trias beds in the vicinity of the gold belt.

The Jurassic consists of limestones and light colored sandstones with occasional bands of quartzite at the base and variegated green, purple and red sandy shales in thin bands above. These beds average about 600 feet and resting conformably upon the variegated beds is a massive light yellow sandstone occasionally conglomeratic at the base. Then follows a series of sandstones becoming quartzites above, intercalated beds of black argillaceous shale with a thin band of coal occasionally near the center of the series, and finally, compact, massive, vitreous quartzite, averaging 40 feet in thickness forming the summit of the upper Jurassic series, whose thickness may be computed at about 125 feet. Farther down the valley this formation is much broken. Above this uppermost quartzite band (which we think corresponds to the Dakota group of the Cretaceous) come the black shales of the Colorado group of the Marine Cretaceous.

The sedimentary beds are cut by numerous vertical dikes, from a few inches to several feet in thickness, having an easterly and westerly course. These dikes have been the source from which an intrusive sheet of porphyrite has spread laterally above the upper or ore-bearing quartzite, or in the shales immediately above. In the vicinity of the gold belt this porphyrite reaches a maximum thickness of 400 feet, further east it becomes mountain masses. This porphyrite appears older than the ordinary Tertiary eruptions of this region.

The limestone bands on the lower portion of the Jurassic, where cut by vertical fissure veins are in some instances extensively mineralized on either side of the veins.

Again there are extensive horizontal ore deposits in these limestones where there are no developments at present to show whether or not they have connection with fissure veins. These limestone ore bodies are iron and copper pyrites, carrying from one to two ounces of gold and the same of silver per ton.

In the gold bearing quartzite belt, the ore is principally in the form of oxides of very irregular shape, marking the locality of fractures or fault planes.

These ore bodies do not extend into the shales, but are exclusively confined to the upper portion of the quartzite.

"The reason" says Mr. Kedzie, "that the ore bodies occur in the upper portion of the quartzite may be due to the existence of a shear fault along the plane below the quartzite and the shales above it, thereby assisting in opening channels, in the fractured quartzite, for ore bearing hot solutions, but effectually closing any fractures in the compressible somewhat impervious shales. The most extensive lateral displacement of a vertical fissure is 35 feet above the Neodisa vein just north of the gold belt. There are also minor faults at other places."

The remote origin of the ore deposits seems to us to be connected with the eruptive dikes and intrusive sheets of eruptive rock found cutting across or overlying the quartzite zone in which the ore bodies wholly lie.

We may suppose that heated waters or vapors ascending with the eruption of the dikes and intrusive sheets circulated amongst the joints and interstices of the sandstone metamorphosing the sandstone into quartzite by their heat and enlarging

and eating out any soft places, joint planes, or any other natural lines of weakness and filling the cavity so formed with sulphide ores which subsequently became changed into oxides and broke up into loose friable matter carrying more or less gold.

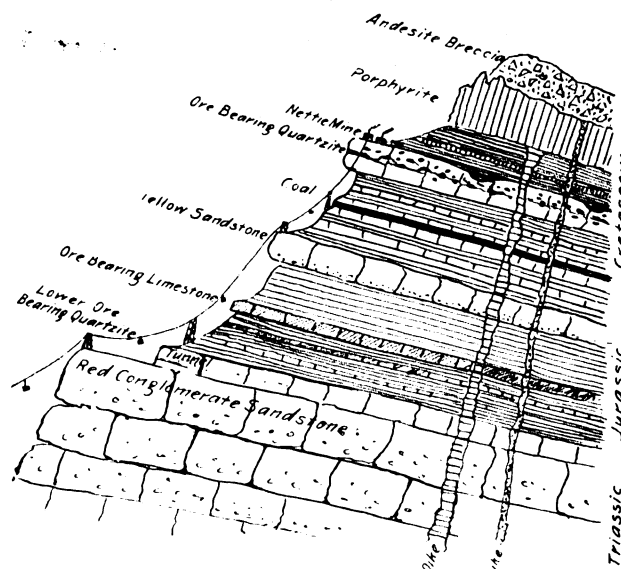
That the waters that did this work were heated and probably alkaline is implied by the fact of their depositing often a coating of quartz crystals as a lining of the cavity. Heated and alkaline waters are solvents of quartz and are also those most apt to carry ores such as sulphides in solution.

We do not think that these cavities were formed exactly like those at Leadville by a substitution or metasomatic interchange of molecules of ore with the molecules of rock for there is no gradual fading off of the ore into the country rock, but on the contrary the ore is well bounded by the walls of the cavity and when the ore, either sulphide or oxide, is removed the surface of the cavity is round and smooth as of a cavity formed by water.

We think in this case the cavities were formed prior to being filled by the ore, or were filled immediately on forming by the same waters that excavated them.

That heat and metamorphic action were connected with the ore deposition is implied by the fact that when the rock is comparatively an unaltered sandstone, it is barren, but when highly silicified or quartzitic it is apt to be rich.

Besides the rounded cavities, the occurrence of the ore in



APPROXIMATE SECTION OF AMERICAN NETTIE HILL

short fissure veins is natural, the waters filling any sort of crack or crevice opened to them. The faulting movements observed in the mine appeared to have been subsequent to the ore deposition, as the fault planes and zones of crushed rock due to faulting are barren of ore. The confinement of these ore zones to the quartzite ledge seems accounted for by the comparatively impervious character of the overlying body of black shale which like an india-rubber sheet would prevent any solutions rising into its mass, and confine them to the more pervious sandstone or quartzite below.

The Seattle Assay Office.

Written for MINES AND MINERALS, by D. A. Lyon.

On June 17th, 1898, President McKinley appointed Mr. Fred A. Wing as Assayer in charge of the United States Assay Office, at Seattle. Honorable George E. Roberts, Director of the Mint, came out from Washington to arrange for the installation of the office. Its present location on Ninth Street was decided upon as suitable for the purpose, being detached from other buildings and so situated as to be somewhat private for miners and others having gold to be assayed. Mr. Wing took charge and as fast as the equipment, which had been purchased in the East, was received, it was put in place. The office was thrown open for business July 15. On July 17, which happened to be the first anniversary of the arrival in Seattle of the Steamer Portland from the North bringing the first Klondike gold, the office received its first shipment of gold dust, which was about \$500,000, being sent by different individuals and the banks in Dawson. During its brief existence, this office has had a phenomenal record. The total amount of gold dust deposited and assayed from July 15, 1898, to October 10, 1900, a period of 26½ months, was \$37,461,584.17 or nearly one-and-a-half million dollars a month. The following is a record of the gold received at the Seattle office during the above mentioned period:

Fiscal Years.	No. of Depositors.	Ounces of Gold Dust.	Assay Value.
July 15, 1898, to June 30, 1899	3,429	414,508.30 ³⁰ / ₁₀₀	\$ 6,504,952.64
June 30, 1899, to June 30, 1900	5,898	849,611	13,630,326.58
June 30, 1900, to Oct. 10, 1900	4,692	1,069,665.75 ⁷⁵ / ₁₀₀	17,326,304.95
Totals	13,929	2,333,785.05⁰⁵/₁₀₀	\$37,461,584.17

Number of assays made since July 1, 1900, over 10,000.

Number of assays made since opening of office, July 15, 1898, over 35,000.

The Assay Office is divided into three working departments, namely, the clerical department, the melting room, and the laboratory, or assaying department. The clerical department is made up of the receiving room, the general computing room, and the offices and vaults. It is here that the gold is received, from the miner or depositor. He sees it weighed and receives a receipt calling for the number of ounces of gold dust deposited. Each deposit is numbered, and is melted into a separate bar and stamped with the number which it has been given and this number follows the gold throughout the work of the office. Every bill, check, account, as well as the weighing and reweighing of every grain of the precious raw metal, the assays made upon the gold bricks, all are checked and double and treble checked. This is for the purpose of safety and accuracy and has been reduced to such a fine system that all mistakes are quickly identified and corrected. After a depositor has received his certificate of deposit, he has to wait for a settlement until the gold has been melted and assayed. This generally requires about twenty-four hours. He then receives payment for the amount of gold contained in his deposit either in the form of a check drawn in his favor, and for his convenience may be on New York, Chicago, or San Francisco, or he receives his pay in coin through the local depository.

After the gold has been weighed, it is taken to the melting room. This contains eight furnaces, furnished by the American Gas Company, and heated by city gas, aided by strong blasts of air. A degree of heat reaching 1,400° to 1,600° Centigrade is obtained in this style of furnace. The gold received here will melt at about 1,000° Centigrade. It is melted under proper fluxes, such as borax, bi-carbonate of soda, or nitre and in some cases special fluxes have to be used on account of the various impurities contained in the dust, which sometimes requires a great deal of experimental work, as in the case of the Nome dust which contains calcium tungstate, and which gave the melters a great deal of trouble. All the slag that is formed during the melting is crushed and panned and the amount of gold saved in this manner added to the weight of the bar from which it comes, so that the depositor gets paid for that also. All gold dust as received contains more or less earthy constituents such as black sand, quartz,

garnets, and red hematite. All of these have to be fluxed out and of course show up as loss in melting. This loss varies from 2% to 5% in fairly clean dust, but in extreme cases it runs as high as 15%. The melting room has a capacity of \$750,000 a day, which limit has been reached on several occasions.

After the gold has been melted into bars, it is sampled and the samples assayed by the usual method of gold bullion assaying which is done in the laboratory, or assaying department. This department decides the grade and value of the gold of every depositor, and for this reason great care is exercised in the selection of the men employed. At present five men and one helper are doing the work of this department, and it is the policy of Mr. Wing to make all around men of these, not simply individual workers or furnace men. The increase in the volume of business since the office was started, has necessitated a large increase in the plant and material as well as in the force of men which now numbers about twenty-six. The present building is being leased from year to year and the office will probably remain where it is until Congress shall make an appropriation for the erection of a suitable building of its own.

A Modern Machine Shop.

The new machine shop building which the Lunkenheimer Company has just completed is situated on the block bounded by Tremont, Waverly and Lawnway Streets, Fairmount, Cincinnati. This building is ninety feet wide by one hundred and seventy feet long, two stories and basement, and is built on the usual machine shop gallery style of construction. There is a traveling crane thirty feet wide which runs the full length of the building, leaving galleries on the second floor, on both sides, thirty feet wide. The construction is steel throughout and designed to safely carry a load of three hundred pounds per square foot. This building was erected for the purpose of taking care of three important departments of the company; viz: iron valve, injector and safety valve. It is, strictly speaking, a model machine shop and is equipped throughout with the very latest tools and appliances for producing the articles mentioned above. The steam plant consists of a 125 H. P. special Babcock & Wilcox boiler built for a safe working pressure of four hundred pounds per square inch. In connection with this boiler there are a number of appliances for testing all goods under steam, air and hydraulic pressure. The building is lighted by electricity and the power is furnished by a 100 H. P. engine. The exterior of the building presents a very handsome appearance, being pressed brick throughout. The location is an excellent one for manufacturing, railroad facilities are ample, and a track spur from the C. H. & D. railroad leads to one side of the building. The erection of this building will not, in any way, reduce the building now occupied by the Company on East Eighth Street, Cincinnati, which will hereafter be entirely devoted to brass work. The Company contemplates the erection of a large building on some other property which it owns which is adjacent



NEW SHOPS OF THE LUNKENHEIMER CO.

to the new building, but it is not likely that this will be carried out for another year. By the erection of this new building the manufacturing facilities have been increased about twenty-five per cent. and employment is given to one hundred additional men, making five hundred hands in all, engaged in the production of high grade brass and iron goods and engineering appliances.

THE FUTURE OF MINING.

The Opportunities It Offers and the Best Means of Attaining Success in the Profession.

By Dr. Nelson P. Hulst.*

The few remarks I shall make will be mainly upon the opportunities which the present offers and the future promises to mining students, together with a little advice which I trust may be helpful. The term "mining students" I take to include not only those who have their thoughts and hopes turned towards mining, but those also whose aspirations are in the direction of the allied industries of milling and metallurgy.

The present offers unexampled opportunities to mining students, and the future promises them in even greater abundance. Throughout all the mining districts of our country the activity in mining of all kinds of metals and minerals is greater than it has ever been. Nor is this activity confined to our own country, for the columns of the daily newspapers tell us in every issue that the quickening of the industry is world-wide. No region is so remote, none so inaccessible, that the hardy miner does not make an effort to reach it.

It is a matter of history that the miners, the seekers after metals, have been the earliest explorers of what were to them far distant countries. The Phoenicians knew and traded with the primitive tin miners of Cornwall long before Rome was built. Africa was circumnavigated in the search for metals in very ancient times and quest of the precious metals aided or promoted the discovery of this western world. To come down to more recent times the discovery of gold in California kindled afresh a mining fever throughout the world and bred a race of miners which has never been discouraged by obstacles.

Necessarily since mining has started into more vigorous life, the cognate industries of milling and metallurgy are throbbing with an energy never before known. We do not need to stop and inquire why this new century, just at its birth, is having such a baptism, such an infusion of energy in mining and its allied industries. It is of more vital importance to have assurance of its continuance.

There would seem to be the best of reasons why mining should become more and more attractive to prudent investors. It is very notable that the business of mining is getting to be conducted with all the care and thoughtfulness that is applied to any business, and when so conducted it is as reliable and profitable as can be desired. Then there is the rapidly accumulating wealth of the country which must seek investment in new channels, and mining as it becomes safe is the more inviting because of the chance of larger profits than in ordinary commercial enterprises. If we consider the enormous production of ores and metals in our country we must acknowledge that new mines and mining districts must be opened up continually, so that a supply may be assured. The production of iron ore in the Lake Superior region has increased by leaps and bounds in a comparatively short time. In 1870 the annual production of the entire district was less than one million tons. The production for this year, 1900, will be about twenty million tons, an increase of two thousand per cent. in thirty years.

The production of copper has had an equally phenomenal increase. We might go through the list of metals mined in the country and we would find that each of them, with the exception of silver, has showed an annually increasing production. The growth of our country in population and wealth means an equivalent increase in the demand for our constructive metals. Therefore additional metal mines will be required to provide for our annually increasing wants. The extension of railroads is continually opening up new mining districts which have hitherto had a precarious existence because only the highest grade ores could be successfully handled. With the advent of the railroads the lower grade ores, far greater in abundance, are made to have a value, since now by reason of low freights they can be carried to points where they can be treated with a profit. Search is being made even for the formerly much despised rebellious ores, for they are now no longer so, since milling processes and smelting methods have been perfected. It must be admitted that these plausible facts give promise of continued activity in mining.

In addition much effort is being directed toward securing foreign markets for our raw and manufactured products. And how much of promise to ourselves may we see in Africa, just opening to civilization, China about to be metamorphosed into a hospitable nation, the islands of the sea and the South American republics, turning from warfare to commercial enterprises.

Never before in the world's history has so large an area of our earth at any one time been at the point of yielding itself up to a different civilization or to any revolution which combined within

itself the beneficent impulses that this latter day civilization stands for.

Can we not therefore be optimistic in the view that this tremendous energy of the present, having so vast a portion of the earth's area, and new and varied fields to feed its vitality will have a continuance equalling our fondest hopes?

We know what the industrial progress in America has been since its discovery by Columbus, what strides in all the arts the Christian nations have taken within that period and how great a portion of all has been accomplished within the last half of the present century or even within the life of the present generation. But it is beyond the possibility of imagination to picture to ourselves what this New World might have attained to if it had started on its career of industrial progress with all the knowledge, with all the enterprise and wealth which are part and parcel of the present. So we may expect a marvelous growth of peaceful industries in the New-Old countries, which are just being drawn within the influence of the new civilization, since they will have as handicaps in their favor the advantage and assistance which come of present knowledge coupled with the momentum of present energy to vitalize them, and all directed by the skill and wealth at the command of the great modern industrial generals to carry them to a magnificent success. If we make even the briefest study of what the industrial progress has been during the last generation we note that the educated men, students and graduates of the mining and technical schools have contributed their share to it. In the field of mining some of the high places are held by skilled practical miners, who have shown great capacity for business and are adepts at handling men. These brainy men with opportunities for no other education than what was offered and what they have obtained by the close study of all that came within their field of vision, "self-made men" the world calls them, have rightfully risen to be masters-in-chief in their chosen field and in their work they are the peers of the best from the schools. Names need not be mentioned; they are familiar to all who have any acquaintance with the large mines of the country. I might add that the Michigan College of Mines and other technical schools have enrolled their sons as students. What better tribute can be given to the worth of these schools?

In the domain of metallurgy, however, educated chemists and engineers, I mean the American type, have occupied almost the entire field. Their achievements have been glorious. In the smelting of iron they have brought what was a haphazard art to a condition of the highest technical skill. Smelting of iron is now in some establishments conducted with all the exactness of a laboratory experiment. By equal skill in applying mechanical and commercial refinements an economy of production has been obtained which the older rule of thumb furnacemen never dreamed of. In Bessemer steel manufacture the same notable successes have been achieved by our technically educated engineers. Until they took hold of the process to improve it the daily product, per converter, was comparatively small. In line with the usual method of American engineers, effort was made to increase the daily product of the converters, which meant, of course, economy, if it could be accomplished. The first engineer to grapple with the problem, Alexander Holley, devised the removable converter bottom, which permitted an immense increase of daily production. Other engineers followed with other mechanical improvements. Their combined efforts resulted in a distinct American practice which was the envy and dismay of foreign competitors in the same manufacture.

A recital of some of the achievements of the graduates of mining and technical schools would seem like chapters culled from romance, so brilliant have they been. They were never accidents, but the fruit of well directed study. To every scientific student they hold out the encouragement that just as great achievements may yet be wrought out by untiring study.

I am sure that it has been impressed on the graduating class now before me, by their professors and instructors, that their work as students has been for the purpose of making them familiar with Nature's laws. If you have been faithful in your work you have also acquired in a measure the habit of systematic study. Thus equipped with a knowledge of Nature's laws and their relations to one another and with minds trained for systematic work, you are prepared to continue your studies unassisted. Knowing somewhat of the spirit of the students of the College of Mines, I am sure that graduation does not mean to you, as it does to many, I fear, the end of studious effort. Your graduation now brings you to the threshold of your professional career. It is a serious event in a young man's life, or it should be, when he steps out to take his place in the active business world. First of all he should be courageous, that is, must have confidence in his ability to fill any position which one just graduated is entitled to secure. His courage should help him to be brave through the misfortune of failure in getting a position promptly or because of the loss of position for any cause. He should be content to begin in humble

*Extract from an address delivered before the graduating class of the Michigan College of Mines.

capacity, be willing to accept any place which has to do with his profession, although the salary may be considerably less than a choice in other lines of work. It is better to begin modestly and know the pleasure and comfort of reasonable advancement than to try to fill a loftier position and fail in the effort. A young man should not be swerved from his chosen profession even if discouraging setbacks and rebuffs are suffered. This matter of being courageous is an essential quality to success, and no man has so much to cultivate the spirit of hopefulness, which is an element in courage as one engaged in mining. I feel impelled to urge you just graduating to be courageous, for I have known of young men starting out eagerly, as you are about to start, who were soon discouraged. The memory of a young man comes now to mind, who at my suggestion took a place as timekeeper. When dullness overtook the iron trade the mine where he held the position became idle and the fellow lost heart. He was too sensible, I know, to think the place below a man of his attainments, but I fear he thought it was a long way from timekeeper to superintendent or something higher. I urged him to hold on and endeavored to encourage him by the assurance that times would improve, and that the mine could not be idle very long. I failed to persuade him and he went off—to vegetate in a country store. With his ability and his address, I am sure he would have risen to a good place in the mining profession if he had only been courageous.

Methodical, systematic habits of work should be assiduously cultivated at the beginning of your business career, until they become established as part of your nature. The man who does things in a haphazard way, the unsystematic man, accomplishes very little at much cost of labor.

It is worth your while as you are looking out into this world of competition you are about to enter to think of how success is gained in athletics. Athletics are an epitome of business or professional life, the drama of life compressed into a few short months at the most. The contestants know that good, hard work is in store for them, if they wish to win, and so they begin the training. Everything is subordinated to such exercise as will put them in perfect physical condition, sacrifices are made, heat and toil are endured, simple living is followed, all with the simple aim in view—victory.

But in athletics, as you know, victory does not always come to the strong, but to that one, or to that team which has been conscientiously systematic in training. The men who make no success in business, profession or otherwise are for the most part those who neglect such simple laws as govern in athletics. They have been content to be unsystematic in their training, they have been unwilling to make sacrifices, they have shunned the heat and toil that were necessary. Could anything else than failure overtake them? The operation of the law of the survival of the fittest pushes them into obscurity, which you will say with me they have justly merited.

Think of yourselves as athletes preparing for a struggle for victory. Your school life has been only the practice ground where you have acquired a fondness for your chosen work, the kind of game if you will. Your real training for your life's contest is to begin now. If you are ambitious enough to start into thorough training, ready to make sacrifices, willing to endure the heat and the toil, I can say for you that the victory will be yours.

Some of you, I hope all of you, have read the brief soul-stirring appeal to young men, entitled, "Carrying the Message to Garcia." It is like the bugle note before battle, rousing one to be courageous and encouraging one to the fullest measure of duty.

It reminds me of an incident which came to my notice about the time that I was beginning my life work. The scene was a rolling mill, in which a most accomplished scholar, a graduate of the famous School of Mines of France, had taken a position as engineer. The first day of his incumbency he was called on to arrange for the construction of a new rotary squeezer, as the one in use was repeatedly breaking down when the so-called red hot puddle balls were ready to have the cinder pressed out of them. In order not to disarrange the shaft connections the new machine was required to occupy the place of the defective one. This necessitated the taking of all measurements of the machine in situ. It was a most inconvenient dirty job to get them, for the machine was hot because of its hot work. It was almost continually drenched with water. It was greasy and filthy in the extreme. The Frenchman walked about it for a day, eyeing it this way and that, and then asked the manager of the works for a draftsman to take the measurements, giving as an excuse that the work would be very dirty. Yet he knew when he was engaged that he was to be draftsman as well as engineer. He walked about the machine another day, prodding the greasy places with his cane, to the utter disgust of the manager, who quickly dismissed him, giving the work to a young man about the mills who was not afraid to don overalls and tackle the disagreeable job. He speedily took the measurements and permission was given him to put all the pig metal into the design that was possible (for the mill turned out

that commodity), so that the machine would have the requisite strength for the work. He produced a machine that met all expectations. It endured for years, and so did the favor of the manager of the works for this fellow who accepted the orders, undertook the work gladly, with only the thought to execute them as desired.

I appeal to you to set your aim high. In other words, be ambitious and stick to your aim with unflinching persistency. If you hope to be a mine superintendent or manager of mines then have the singleness of purpose to win such a position. You may be sure that it will not come to you unless you have striven to make yourself capable of such a responsibility. And I would recommend that you choose early just what metal mining or other vocation you wish to pursue as a life work. Think of your work as life work. Whether it be iron or copper or precious metal mining; each has a field to itself which comprises enough to absorb all of your effort if you will be master in that field. You should make earnest effort to be an authority in whatever you choose as your vocation. It will always be an aid to you in your profession to hold such a position. To that end you should study the literature pertaining to your branch of metal mining and its allied industries, if mining be your choice. There are many others who are working along the same lines as yourself whose acquaintance and friendship you should seek. Don't be a recluse. In the industrial world such men are unbalanced. Every man unconsciously inclines to work in a rut. He only gets out of it by seeing what others are doing in the same field or by reading all the literature pertaining to it. There are the societies like the American Institute of Mining Engineers, the Lake Superior Mining Institute, and other local engineering associations, in some one or more of which you should seek membership. And you can get valuable information from the humble miner underground. Treat him in a manly way, as he may be deserving, and he will respond to your inquiries for information with an alacrity which will make you his friend. It is worth remembering that from the underground ranks some of the very ablest of our mine managers have risen; and it will be a profitable study for you to ascertain why old Cornish miners you will meet underground have remained in the work where they are and why others who were their associates in early days have since attained to places of the highest responsibility. You may be confident that such a study, if undertaken by you, and if the lesson it teaches is well heeded, will help you towards success.

If your choice is the field of mining do not be particular as to your introduction to it. Your main purpose should be to get a foothold with some honorable employer, be that employer an individual or a corporation. The position attained by you at first may not be to your liking, may not be one which requires the exercise of your abilities as a chemist or engineer, but by all means hold on to that place that you may demonstrate to your employer or his representative that you have the admirable quality of persistency. Some of us remember that when General Grant was getting hard knocks in his battles in Virginia, his plan of campaign was adversely criticized by his detractors. Beseet by discouragements which would have appalled a weaker man, he shouted back to his calumniators, "I will fight it out on this line if it takes all summer." All the loyal people of the North felt their backbone stiffen when this memorable message was published.

If you show thus in times of discouragement that you are a gritty man you will always win friends. You will force recognition, for it is instinctive in the human race to admire a resolute spirit. Having thus shown your pluck you are in a fair way to the opportunity to demonstrate your abilities. The old adage "a rolling stone gathers no moss" is one that as we come into larger experience has its truthfulness repeatedly proven. Not many years ago I was importuned by an engineer for a position under me. I could give the man no encouragement whatever, my firm belief in the proverb I have quoted influencing me to this decision. On the back of his personal or official letter paper copies of commendatory letters, twenty or more in number, covering but few years of service, indicated that he was one of the rolling stones. Although his services had been valued evidently there were reasons not given which limited their duration. I did not care to ascertain what these reasons were.

The ability to handle men is one of the most valuable in the whole list which a man should possess who has charge of mines. It has been this ability possessed in large degree by the practical miners which gave them the start and has helped them to preferment and to success. You should be most diligent in your efforts to acquire this ability, not that you may be called on to exercise it directly. Its value to you some day will be perhaps in the judgement you will have as to whether the captains or bosses under you handle your men so as to get the maximum results from their labor. Success in mining, as in any industrial pursuit, is measured by the profit obtained. It will stand you in good

stead therefore some day to know whether the labor you may be employing is distributed to best advantage. Sometimes a mine is accounted an unprofitable one by the general public, when in reality the fault lies in the manager, not in the mine. In almost every mining district you will find such sorry examples of mines. A visit to these unfortunate properties discloses a lack of thrift which is seen on every hand. At the beginning of your career, as you value your hope of future success, be careful to avoid taking any position at such a mine. Bad practice will corrupt your training and it is to be shunned as something pernicious.

As before stated, success in mining is measured by the profit obtained in the operation of it. My earnest advice is that you bend all your energy to the acquirement of habits of so performing your work or so directing the work of others as will accomplish economies.

At all well managed mines an important part of the office work is the determination of the cost of product per ton. The cost sheet shows the subdivision and varieties of labor and the part each bears in the total cost of production figured out in cents and fractions thereof. The insignificant cent is a matter of profound consideration. You will find that in an estimate of cost even the mills are watched with more interest than you may have been accustomed to give to dollars. In the company I represent a saving of one cent on the cost of producing a ton of ore aggregates in this year's production a saving of over fifty thousand dollars.

You have no doubt noticed how in trade papers and magazines representing industries in general their columns are everflowing with articles on shop costs, in fact with studies of economies in every direction.

It has been this incessant study of and striving after economies which has brought mining and other industries in our country to the position of superiority they hold above the same industries elsewhere. The high wage scale which has compelled this study and striving has been the greatest blessing to us, for we have been forced thereby to the discovery that machinery, properly applied, can make human labor immensely more effective—that greater economies are thus obtained than by reducing wages. This attitude towards the use of labor saving machinery constitutes in great measure the difference in business methods between other countries and our own. With us in the up-to-date enterprises wherever a machine can be introduced to augment economies a machine is installed. This is notable in mines where the management is alert. You will therefore find it a most profitable study to give thought to the use of labor saving machines, although you may at the time have no opportunities to apply them. Don't think that you must defer such study until you get to be mine captain or higher. You should begin it as soon as you have taken a place at a mine. I do not mean that you necessarily are to spend your time in the effort to devise labor-saving machinery. This is more especially the province of the mechanical engineer. You should rather give as much time as you can to discovering places where a machine can profitably replace manual labor and let the engineer devise what is needed. However, before making suggestions in this line to your superiors, be sure that you have canvassed thoroughly all the conditions of the problem you hope to solve by the application of any device. It is of greatest importance that you make no errors in your earliest efforts of this nature. Once you have been successful in this direction you will have a spur to your ambition which will surprise you.

It is the men who do the original thinking, thinking of a kind that works out economies, who forge ahead of their fellows in the struggle for advancement. I have had young men, fresh from mining schools, ask advice as to how or where to start in mining work. I have replied that if I had the opportunity of beginning my life work again educated as they were, I should count it most advantageous to begin as low down in the work as timekeeper. The place of timekeeper cannot hold down very long an educated, ambitious man. Nor does it demean his education to thus apparently ignore it when starting into life work. I am glad that I have the opportunity of saying it to you young men, educated with a view to mining, that the duties of timekeeper in a mine afford greater opportunities of acquiring knowledge, such as you ought to have, than any other position. My reason for claiming greater advantage in this position over that of chemist and engineer is that it brings you in daily contact with work with which these officials have little or no experience.

Your instruction has been in chemistry, surveying, mineralogy, geology, and other branches, and all for what—to provide a groundwork on which you are hereafter, by your own efforts, to rear the superstructure which is to take shape or reality as professional or business success. It will be lofty or otherwise, just as you choose to make it. There is no occupation about a mine which brings a man in closer relations with the common laborer, miner or artisan, than that of timekeeper. His almost unofficial position promotes an intercourse devoid of the usual reserve which separates all classes of labor from higher officials. He must needs know the

men by name and they account him as one of their own number, if he is in any way considerate or tactful. If he be a student of human nature he will have unusual chances to observe how the workingmen think and act under different impulses, will get to know their point of view of things, how they are affected toward their employers, who of the working force are honest and who are dishonest. There is no office which is its equal in teaching men to read human character. If a timekeeper be a man of discernment he will quickly learn whether the working force whose time he takes is always well distributed. By noting what a conscientious workman accomplishes in a day he will come to know what is the honest measure of a day's work. He will learn to distinguish between shift bosses or other foremen in respect to their ability to handle men and his duties require him to follow every kind of labor in operation about a mine. He is thus in the best school of training to learn how to handle men. The peculiar nature of his especial work begets habits of promptness. His duties cannot be put off till the morrow, or later, for delay might mean inaccuracy in his records, an unpardonable fault. Then he has the working force of a mine, more or less, keeping time for themselves (it being a matter affecting their pockets), which honestly or dishonestly will check his record. He knows therefore that to be able to stand by his work he must be rigidly accurate. Thus in this department there is daily training which must establish the valuable habits of accuracy, promptness, diligence and system. The daily trips of a timekeeper through and about the mines will give him very speedily a comprehensive notion of the property. If he is eager to learn about the occurrence of the ore, its quality, how it is won, how handled, then his frequent and regular trips afford him object lessons as full as he could wish, and every day he can have for mentors the miners themselves.

If you wish to build the broadest of foundations in a practical knowledge of mining then you will do well to believe with me that the humble position of timekeeper, a place not difficult to fill, is worth the consideration of the graduate of a mining school.

After you have occupied the position of timekeeper long enough you should endeavor to get the opportunity to work on the cost sheets. You cannot familiarize yourself too much with the methods of determining costs. It is here that the results of efforts at saving are seen in detail. You note the consumption of supplies. You learn the value of the large divisor where costs are concerned, since a variable monthly output, the divisor, shows its effects on what are called the fixed expenses per ton. You will learn that the manager or superintendent, if alive to his duties, is given to closely scanning his cost sheet, which is the epitome of the results of his work. You will find that he notes with daily interest the record of product of tons per man per day of output. To him these observations indicate the relation of his work to profit or loss, to success or failure, just as the daily observations and reckoning of the navigator locate his position at sea.

You should cultivate the habit of diligence, so get to love work that you become a hustler. Such men are being hunted for, while the ease loving fellows, because of their shrinking from work, are left to drop out of use and out of sight.

I have endeavored to show you how hopeful we may be that the present activity in mining will long continue, and that it has the brightest of opportunities for the educated man. I have striven to impress on you the necessity of ambition, courage, persistency, and that to attain a commanding position you must go into training with the singleness of purpose of an athlete. I hope I have fully persuaded you that you must consider successful work as very largely the accomplishment of economies.

I cannot close without saying a word about that priceless element of character, honesty. Be honest always in the most trivial things. Make it an inflexible rule of your conduct that in time it may become a part of your very nature. Never drift into slipshod work, whether it be that of timekeeper, chemist or engineer, for such work would be dishonest work. It would be dishonest to yourselves. It would not be rendering to your employer what he expects, and what he pays for—your best efforts. From a slipshod way of doing things the steps are very easy to greater acts of dishonesty. Cultivate, therefore, the habit of always doing your best, and you will become girded with an armor which has no weak spots for the foils of the tempter.

The steady effort to do your best will not only ennoble your character, but it will bring to you in time that sweet reward—a glorious success.

It is often asked why gunpowder retains its hold as an explosive for use in coal mining. Its advantages are that it loosens the coal, and does not shatter it as many other forms of explosives do. This gives the coal product in large blocks and gives a minimum of fine material. Its disadvantages are the flame which it gives out in ignition and the noxious gases which usually accompany its ignition.

COAL MINING ON VANCOUVER ISLAND.

Facts in Regard to the Mines Which Have Been Opened and the Amount and Method of Development.

Written for MINES AND MINERALS, by R. Luid Watson.

For years the coal of Vancouver Island has been regarded as the best on the Pacific Coast. It is bituminous in character and Cretaceous in origin. The coal measures lie in a narrow synclinal extending along the east coast of the Island from Cape Mudge to within fifteen miles of Victoria. They are bounded on the west by a range of mountains of the Vancouver crystalline series; to the east, they dip under the waters of the Gulf of Georgia, reappearing on some of the islands of the Gulf.

This Cretaceous trough is divided into two areas separated by a line of crystalline rocks situated near Nanaimo harbor. The one to the north-west is known as the Comox area; that to the southeast, as the Nanaimo area: both contain important collieries.

A large patch of Cretaceous also occurs at Fort Rupert, north-east of Vancouver Island, and continues westward to Quatsino Sound.

Historical Sketch.—Coal at Beaver Harbor and at Squash Creek, near Fort Rupert, was made known by Dr. W. F. Tolmie, in 1835. In 1849 the Hudson Bay Company brought out some miners from Scotland—among them Robert Dunsmuir, the future coal king. Exploratory work was done between Fort McNeil and Beaver Harbor. At Squash Creek they bored 150 ft. and cut through a coal seam 5 ft. thick. In 1851, they began sinking a shaft and had got down about 25 ft. when orders were received from Governor Douglass that all mine hands should go at once to Nanaimo,—the existence of coal there having been disclosed by the Indians the year previous, viz. 1850.

Work at Nanaimo began in earnest in 1852. Before the close of 1853 2,000 tons of coal are reported to have been shipped to San Francisco, the price at Nanaimo being \$11, and at San Francisco \$28.

The mine was worked by the Hudson Bay Company under the name of the Nanaimo Coal Company until 1861, when it was sold to the New Vancouver Coal Mining and Land Company, Limited, an English joint stock company with headquarters in London.

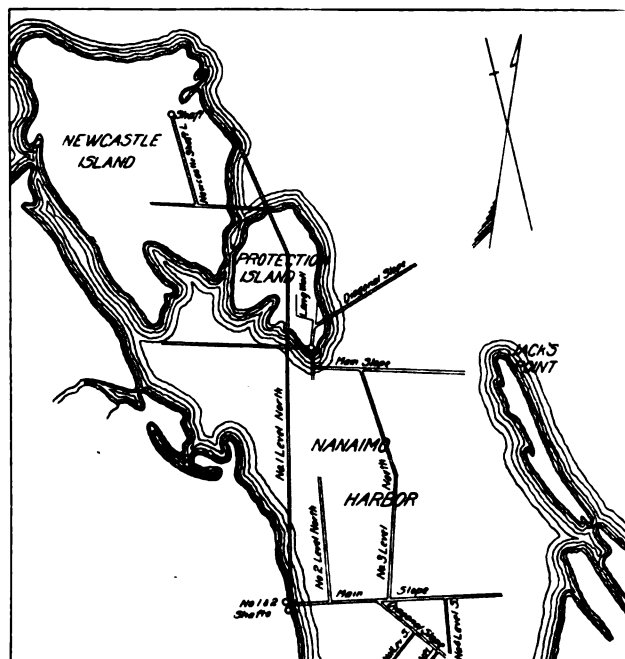
VANCOUVER ISLAND COLLIERIES.

1. Nanaimo Colliery owned by the New Vancouver Coal Mining and Land Company, Limited.
2. Wellington Colliery owned by Messrs. R. Dunsmuir and sons.
3. Union Colliery owned by the Union Colliery Company of B. C. Limited (Dunsmuir).

Some work is being done at Quatsino by the West Vancouver Island Commercial Co., how much we have been unable to ascertain.

Out-Put.—The output of the Vancouver Island collieries for the year '98-'99 was 1,203,200 tons, an increase of 85,285 tons over the previous year which had itself broken all former records. The decided increase of the past two years indicates a greater demand, accounted for by the growth of mining operations in British Columbia and the importance of the northern trade.

San Francisco and Southern Californian ports constitute the



MAP SHOWING LOCATION OF COAL MINES ABOUT NANAIMO.

chief market. Shipments are also made to Mexico, Central America, Hawaii, China, and Japan.

NANAIMO COLLIERY.

This is the oldest and largest producing mine on the island. Its output in 1899 was 614,800 tons. The charter of the New Vancouver Coal Mining and Land Co. dates from 1862. The coal lands of the company amount to 30,000 acres. In 1881, at a point east of the old Douglas pit a bore-hole was put down. At a depth of 650 ft. it passed through a coal seam; thickness 8 ft. 6 ins. On this showing and on the advice of an eminent engineer two circular shafts, 200 ft. apart, were sunk. These are known as No. 1 and No. 2 shafts. Suitable hoisting, pumping and ventilating apparatus was installed. Shipping began and has been continuous ever since.

The company has the following pits: No. 1 Shaft, Esplanade, Protection Shaft, Newcastle Shaft, No. 5 Southfield, Northfield Shaft (idle '98-'99). With the exception of the north and south fields all the workings are under the harbor of Nanaimo and beneath the surface of Protection (Douglas) and Newcastle Islands.

No. 1 Shaft, Esplanade. This shaft is situated within the city of Nanaimo. There is an extensive plant on the esplanade, including besides offices a power-house where electricity is generated for the underground motors and for lighting; a fan-house, containing a Guibal fan 36 feet $\times$ 12 feet, an engine room, goods depôt, machine and smithing department, carpenter shops and many et ceteras.

The platform of the pit-head is built of fir and is 25 feet above the ground; the winding frame and gear rise 50 feet above the platform.

No. 1 Shaft is circular with a diameter of 18 feet; it is bricked where necessary for safety; its depth, 650 feet. The cage makes the descent in about 25 seconds. At the foot of the shaft there is a sump. Water beyond the capacity of the sump and lodgment, is removed by a Cameron force-pump.

No. 2 Shaft is also circular, with a diameter of 16 feet. It is situated 200 feet north of No. 1. Being used as an "upcast" it is air-tight and is connected by underground passage with the ventilating fan. Winding-gear is kept above the air-shaft, and by removing part of the pit cover, hoisting could be done, in an emergency, on ten minutes' notice.

In 1887 No. 2 was deepened 71 feet and cut a seam 6 feet thick. From borings at other points it has been ascertained that the coal, though somewhat irregular, is good; and that the thickness of the measures between the seams is 60 to 70 feet. When the Douglas seam has been exhausted, this lower one will undoubtedly be worked.

The landing at the bottom of No. 1 Shaft is spacious and is illuminated by incandescent electric light. The main slope runs east from the bottom of No. 2 Shaft for 2,200 yds. From it levels are driven north and south. As shown on the accompanying map levels 1 and 3 north, connect with the Protection workings.



NO. 1 SHAFT, ESPLANADE, SHOWING CHUTES FOR COAL FOR HOME CONSUMPTION.

The levels, slopes, and inclines have a width of 10 to 12 feet and an average height of 6½ feet. There is a good roof and a good floor to the seam, which dips 6 degrees to 8 degrees. Little trouble has been experienced from influx of water. Dust does not occur in any great quantity. Hydrants with lengths of hose are stationed at intervals and the workings kept well moistened. A mass of 450—1,300 ft. thickness lies between the roof of the seam and the bed of the harbor. Faults frequently occur.

Mode of Working.—Work is done on the pillar and stall panel system, the panels being limited areas divided into pillars and stalls. When the stalls are worked to the end of the panel, 200 to 350 yards, solid pillars, some 15 yds. wide, are left which contain fully two-thirds of the original coal in the mine. When deemed advisable these pillars are drawn.

Present Workings.—Work goes on at present (a) in levels 2 and 3 north, where pillars are being robbed; (b) off inclines west of No. 1 level, north; (c) south of the main slope. It is worthy of mention that the work of the year 1898-'99, south of the main slope is the first done in that direction since the explosion in 1887. This was an explosion of gas and coal dust that occurred south of No. 1 shaft and resulted in the loss of about one hundred and twenty-five lives.

The coal of 1 and 2 levels, south, off the original slope, has been found to be of good quality. At the end of the levels at time of visit, December '99, the good coal was observed to be mixed with considerable of a scaly and worthless nature.

Haulage.—For 2½ miles along No. 1 level, north, and 1½ miles along No. 3 level, north, haulage is done by electric motors, of which there are three. These motors are capable of drawing 96 cars at one trip. When carrying live freight they run at a rate of five or six miles an hour, but when the cars are filled with coal they run at a much greater speed. Sidings are provided at which they may pass. The coal from No. 3 level, north, is hauled up the main slope by a steam winding engine, situated at the head of the slope. Where the electric system does not reach, mules or pushers are used.

There are about seventy mules in the mine. The stables are situated south of No. 1 shaft. On account of insufficient room, additional stables have been constructed at Protection Island, which enable all the mules to be housed underground.

Ventilation.—The ventilation is on the separate split system. Protection Island shaft serves as the "intake" for all the workings, No. 1 Shaft being the intake for that portion of the mine in its vicinity and for the stables. No. 2 Shaft is the common "upcast." It has connection, as we have seen, by underground passage with a Guibal fan 36 ft. × 12 ft. The volume of air circulated through the mine amounts to 150,000 to 165,000 cu. ft. per minute. In case of accident to the Guibal fan there is a Murphy fan that could be utilized.

Wharfage.—The shipping wharves of the Company have a frontage of 2,000 feet. The water of Nanaimo Harbor is of a depth sufficient to accommodate vessels of the deepest draft at all stages of the tide.

Facilities for loading have been greatly improved within the

last few years, and are now excellent. A cargo of 6,000 tons has been completed in ten hours.

Two approaches built of solid filling, except the last quarter of a mile which is of trestle work, run out to the respective wharves, which are 1,500 feet apart. Before reaching the wharf there is a level platform on which are two lines of track to accommodate the full and empty cars. The mouths of the chutes are between the rails of one of these tracks. The apparatus for handling cars is run by steam and proves eminently satisfactory. Huge bunkers capable of containing 10,000 tons have been erected. A reserve supply of coal being always kept in them the loading of a vessel can proceed without delay.

Suitable bunkers and wharves are also situated at Protection Island.

The Mermaid is the Company's steamer used for towing vessels and barges, for making trips to Victoria and Fraser River, and for bringing the men from the Protection Shaft to Nanaimo. The steam launch "Swan" is available for towing, in the absence of the Mermaid; and for making visits to the neighboring islands.

The total number of men employed by this company is about 1,300. The miner is paid according to the amount

of coal he gets out and his wages average from \$3.00 to \$4.50 per day. Two and in some places three shifts are worked, each of eight hours—6 A. M. to 2 P. M.; 2 P. M. to 10 P. M.; sometimes 10 P. M. to 6 A. M.

The Farm.—The Company owns a farm of upwards of 500 acres cleared from the forest, drained and dressed, valuable not only for the crops raised but also for the model it furnishes to the workmen. Should any of these wish to settle, five-acre lots are offered on liberal terms of lease or purchase.

PROTECTION SHAFT.

This shaft was sunk in 1891, and coal struck at a depth of 670 feet, the seam being 3 to 8 feet thick.

The coal is similar to that of No. 1 Shaft mine. In 1892 the shaft was extended 62 feet to the lower seam which at this point has a thickness of 4 feet. The shaft is 18 × 12 ft. and serves as an "intake" for Protection and No. 1 Shaft mines.

From the foot of the shaft two slopes extend towards Gabriola Island, one east, the other northeast, each about one mile in length, but no work has been done on them for some time.

At a point 600 ft. down the diagonal slope, a slant S 81° E has been run about 780 yards for the purpose of taking out the coal between the main (east) slope and the diagonal slope.

The "long wall"

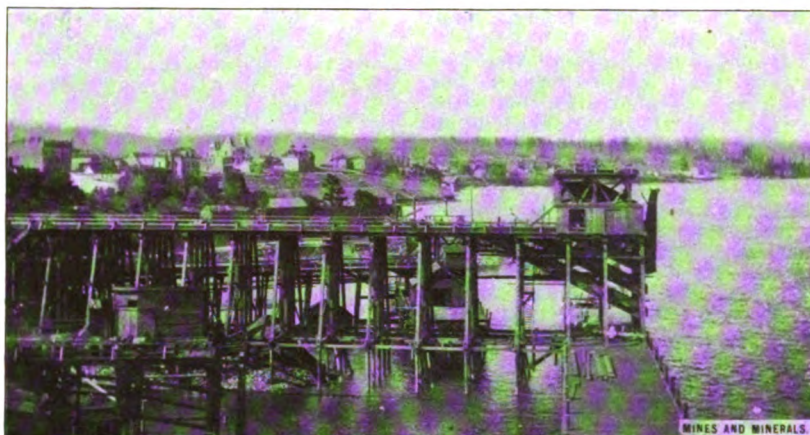
system, is in operation at the point indicated on the sketch, the seam there being only about 3 ft. thick.

In other places, the pillar and stall system is adopted.

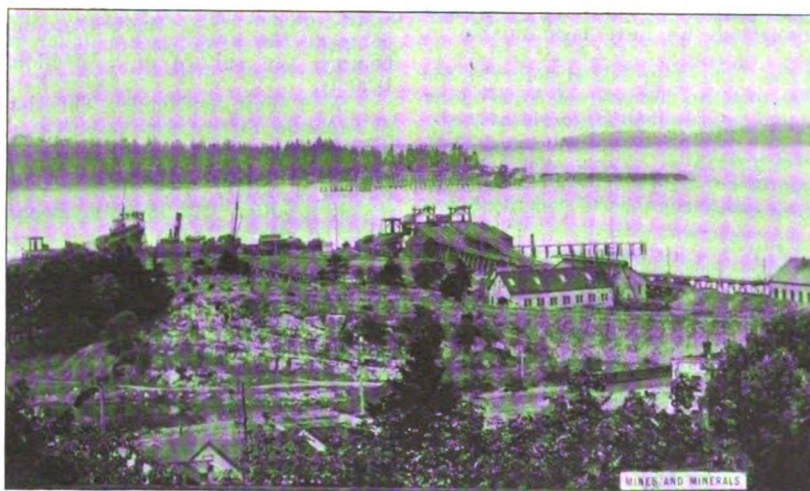
NEWCASTLE ISLAND SHAFT.

Within the past year the sinking of a shaft on the northeast side of Newcastle Island has been completed. The upper seam of coal was struck at a depth of 324 feet; the lower at 384 feet. Sump is 10 feet. Total depth of shaft 394 feet.

The various parts of the works are connected with the superintendent's office by telephone. A wire goes down No. 1 Shaft,



WHARF AT NANAIMO.



WHARVES, ETC., PROTECTION POINT, NANAIMO.

along No. 1 level north and up the Protection shaft to a telephone in the engine-room.

NO. 5 SHAFT, SOUTHFIELD.

This mine is situated 4 miles from No. 1 Shaft and docks, with which connection is made by the company's railway.

The shaft is 508 feet deep and from the bottom runs a slope with level and incline. The coal seam is 5 to 22 feet thick.

Southfield coal has certain well known characteristics. It is a good steaming and coking coal.

NORTHFIELD MINE.

Situated about 4 miles from Departure Bay; shaft 400 ft.; coal 3 to 5 ft.; slope from shaft 1,000 yards. Closed during the past year.

WELLINGTON COLLIERY.

The Wellington Colliery lies six miles north of Nanaimo City and three miles from Departure Bay. It began to produce coal in 1871. Of late years the output has steadily decreased. In October of the present year operations ceased, and the machinery was removed to Ladysmith.

UNION COLLIERY.

The Union Colliery is situated eleven miles northwest of Union Bay and near the farming district of Comox. A year ago No. 6 shaft was completed. Depth 814 feet. Width of seam, 7 feet.

At Union Bay two hundred bee-hive ovens have been erected for the manufacture of coke.

The coke is good, though somewhat high in ash as seen by the analysis:

Moisture	60
Vol. Matter	2.60
Fixed Carbon	80.00
Ash	16.80
	100.00

Trade fell off considerably during the past year owing to the fact that the Crow's Nest Pass supplied Kootenay with coke. At present California affords the best market, but when the metaliferous deposits of Vancouver Island become better opened up there will be a good home market.

Fire clay also is secured from the Union Colliery. Formerly it was brought to Victoria to be converted into bricks; now two kilns, each with a capacity of 40,000 bricks have been erected at Union Bay. The gases that escape in the manufacture of the coke are utilized for drying the bricks. These fire bricks are not able to withstand as great heat as the Scottish bricks, being too rich in silica. In addition to its works at Union, the company operates the Alexandria Mine in the Cranberry District, and Extension Mine in the Douglas District—now, the most important of the mines run by the Dunsmuir.

The Alexandria Mine is five miles south of Nanaimo; seam is irregular; coal 3 to 18 feet thick, of same characteristics as the Southfield coal.

The Extension Mine is on the south slope of Mt. Bensen.

At Ladysmith, situated on Oyster Harbour, the Union Colliery Company has lately erected bunkers capable of holding 10,000 tons of coal; also two wharves, where ocean vessels can load 800 tons per hour at low tide.

A branch of the Esquimalt and Nanaimo Railroad makes connection with the harbour. This is the place of shipment for the Alexandria and Extension mines.

ACCIDENTS.

Accidents are comparatively rare. The total in the Vancouver collieries for '98 was 56, of which 7 were fatal; for '99, 65 of which 11 were fatal; there were about 3,300 men employed. These accidents were occasioned by explosions of gas, fall of coal and rock, mine-cars, mules, powder, timber at pit-head. The most serious was the explosion of Nov. 12, 1898, when the manager, 3 firemen, 2 timbermen and 2 miners were killed. Great care is exercised in the examination of the mines. No shot may be fired until the position and loading of the hole have been approved by the shot-lighter. Firemen are constantly examining for gas. Naked lights—fed with dog-fish oil, are used at ordinary work. The firemen and the workmen's committee of examination use safety-lamps.

American Steel & Wire Co. Acquires Vessels.

In order that it may more completely control its own shipping facilities, the American Steel & Wire Co. has purchased the capital stock of the American Steamship Co. The entire capital stock of the American Steamship Co., has been owned by the inside men of the Steel & Wire organization. The company was formed to operate a line of ore steamers. The fleet obtained consists of 12 ships. They include the four largest vessels on the great lakes, six others have 5,000 to 7,000 tons capacity each, and two canal ships on the St. Lawrence of 3,000 tons each.

THE ILLINOIS COAL OPERATORS'

Plan for Removing the Occasion of Strikes—How the Plan Originated, and the Method of Accomplishing Its Object.

By Herman Justl, Commissioner, Illinois Coal Operators' Association.

The long and bitter strike of 1897 in the bituminous coal fields of Pennsylvania, Ohio, Indiana and Illinois terminated in the autumn of that year, and one of the results was the joint inter-state convention of operators and miners, which was held at Chicago in January, 1898.

Since then the coal operators in that field have recognized the Mine Workers' Union of America and have met with it annually in joint inter-state, joint state and joint district and sub-district conventions, for the purpose of agreeing upon a scale of wages and upon general conditions to be observed for the period of twelve months from the first day of April of each year. No Inter-State Association of Coal Operators, however, was ever formed, although in effect something approximating it may be said to exist, but merely by common consent and not by compact. The coal operators of these several States to the inter-state agreement have, however, as a result of the first inter-state convention, formed, I believe, separate State organizations or something equally effective.

On December 23, 1897, the coal operators of Illinois organized what is now known as the Illinois Coal Operators' Association, but not until June 1 of the present year has this been more than a merely voluntary organization, meeting only at intervals subject to call, passing resolutions and issuing manifestos, but having no machinery of organization with which to enforce any of its decrees, or with which to systematically follow up any plans or ideas that may have been suggested or agreed upon, and what was true of Illinois has been and is still true of Pennsylvania, Ohio and Indiana, neither of these last named states having as yet adopted the idea of a commission such as has been organized under the patronage of the coal operators of Illinois.

The mine workers of these four States, on the other hand, were and are well organized, and have had in the field continuously for several years past national, state, district and local officials and committeemen to do nothing else than to look after the interests of the miners. Every demand made by the miners has been persistently and systematically followed up by the organization through these officials, and whether such demands were in exact accord with the different agreements or not, they were very generally conceded, there being no tribunal to which the operator could appeal, or from which he could seek counsel to guide him.

Thus we see capital practically unorganized coping with labor thoroughly organized and ably officered. The strange thing, therefore, is not that capital has in a sense, and to a slight extent, at length awakened to its dangers and its opportunities, but that the intelligence behind capital has been so slow to realize that the only solution for labor differences, the only way to secure fair play, the only way to hold in check the radical element in the ranks of both operators and miners, was to proceed upon business lines and to meet organized labor with organized capital.

What has been done so far, however, is only a mere beginning, and in so far as the coal producing industry in the bituminous field is concerned, capital is still at a tremendous disadvantage, because it is not well organized, and its immunity from the consequences of sundry manifestations of bad faith on the part of the miners, and their petty tyranny, of which so many operators have complained, will depend upon the public spirit, enlightenment and fairness displayed by the coal operators themselves.

In Illinois, happily, the coal operators, it would seem, have seen with a clearer vision than coal operators elsewhere, the necessity of placing their organization upon a footing similar to that held by the Miners' Union, and this new departure, contrary to the expectation of many, has been hailed with pleasure and satisfaction by the most enlightened leaders of labor in America. They accept this movement, not only as a recognition of their organization, but as a tribute to the fair and honorable disposition of the officials of the Mine Workers' Union, and in return for such high tribute—of such wise and generous recognition—they have placed themselves on record as determined to aid in enforcing upon both parties a strict observance, in letter and spirit, of every agreement and of their every condition.

This is well, for thus the labor union is placed on trial and is given, under the most favorable auspices, an opportunity to prove that its claim to popular sympathy, confidence and favor are well founded; while capital on the other hand will show what even a very modest attempt at organization can do to enforce its rights against unjust demands and to render comparatively tranquil the

conditions of labor in at least a small part of the industrial world. It will do even more; it will show that the operator means to be fair and just in his dealings with the miner whatever has been said to the contrary, and that he is willing the public should know the whole truth about any serious differences arising between master and men.

The labor union, as I have just said, is on trial, and if it is to retain public confidence it must show, not only that it can and does help the laborer, but that this benefit being a practical one, extending to the families of miners, is secured to them without injury or danger or too great a cost to the general public. If, therefore, we are to deal with the Mine Workers' Union fairly, we must deal with it, not sentimentally, but practically and with honest sympathy. We must study its methods for benefiting the laborer as a new system of education, or study it rather as that important phase of the general industrial problem upon which the best minds of the century have expended so much thought and labor.

The labor organization, it must be admitted, stands practically as a monopoly between the general public and the particular employers interested, and, sooner or later, it will come to be generally regarded in exactly the same light as any other monopoly. Therefore, the leaders in the cause of labor cannot be too circumspect. Their cause is on trial now with respect to the manner in which it treats the various employers who are compelled to deal with it and whose continued existence depends upon the uniform fairness and justice with which the organization deals with the various employers. If labor organizations are to prove a permanent success they must not favor one district, locality or class of employers at the expense of another. Nor must they pursue the policy of exacting higher wages and more favorable conditions where they happen for the moment to believe that their organization has the greatest strength, while in another warding off the possibility of a contest by granting special concessions.

Labor leaders must preach and practice equal and exact justice to all and educate their rank and file to understand that it is occasionally necessary to sacrifice some local advantage to the common good, or waive it, until it can be fairly exacted from all alike. It will be fatal to organized labor should its leaders assume an air of proprietorship, such as minor officials have sometimes done, for in a free country like ours the public is not slow to severely rebuke or dethrone petty tyrants or usurpers.

The value to the industrial world then, of the present experiment inaugurated by the Illinois Coal Operators' Association in establishing a Commission, for the purposes hereinafter set forth, will be determined mainly by one result, to-wit: *The officials of organized labor, having entered into an agreement with individual employers, or associations of employers, can they, the officials of organized labor, enforce upon individual employes compliance with all the terms and conditions of such agreement?*

In other words, after they have entered into an agreement can they secure and compel its enforcement? If they can the labor union will not only survive, but it will be universally recognized; but on the other hand, if it fails in its pledges and promises—if a contract entered into by it is to be set aside whenever it suits the interest or caprice of a few mischief makers—it must surely be disrupted, and however gladly many employers of labor might hail such a result, it would be a calamity attended by the gravest consequences. Certainly such a failure would be followed by the establishment of organizations of laborers ten-fold more radical than anything we have thus far known, or be followed possibly by what many timid Americans so much dread, a revolution by the side of which the memorable one of France would seem insignificant. For one, I desire to record my faith in the ability of the American people to solve this great problem, as they have solved all others—wisely, fairly and in a way eminently practical and for the benefit of the human race in every part of the habitable globe. And the way to do this and to consummate so great a boon to humanity, is for leaders among men, both in the ranks of labor and capital, to work together for this end. They must together work with and appeal to the best there is in their fellows of the rank and file—touch elbows with and get closer and more in sympathy with them than has been their wont in our times and in our country. Some eminently practical men laugh such ideas to scorn, but, nevertheless, I for one subscribe to the theory that "The surest way to improve our fellows is to treat them as though they were what they should be."

The step taken by the Illinois Coal Operators' Association and its establishment of a Commission, to which shall be referred all questions affecting the employer in his relations to his employes, it would seem, is the most practical and humane plan so far presented of preventing friction, or the superlative of friction—labor strikes. Primarily, this commission has been

established to help the employers to avoid annoying misunderstandings and to serve as a help in extricating themselves from perplexing complications in which they have become unwittingly involved. Its plan is to prevent friction and to settle disputes with employes by having employers submit their differences to a Commission of their own choice, whose business it will be to take them up with the representatives of the Mine Workers' Union and settle them upon their own merits solely, and while it is true that the Commission is in the service of and represents the operators, it is not in that gross partisan spirit which is blind to the rights of other interests than their own. Showing this fair spirit, it is believed the representatives of labor will be equally fair and that they will thus the more readily use their skill and influence in bringing labor up to the highest standard of excellence, discipline and honor.

It is confidently believed that such a Commission, devoted exclusively to this particular work, and becoming with each successive experience more and more proficient, can and will settle differences and disputes between operators and miners more speedily, more satisfactorily and with greater fairness than is possible in the very nature of things by the busy employer engrossed in the ordinary cares of his business, for we well know that the average business man engaged in coal mining has enough on his hands without acting as his own representative in settling labor differences and disputes, as coal mining is a business in itself just as much so as the settlement of vexed labor questions is a business itself; and since operators and miners are so directly and selfishly interested in the subject under dispute, they are poorly qualified to sit in judgment in their own case or to act as counsel in their own behalf. It has been truthfully said that there are elements in an industrial controversy which appeal too strongly to personal interests to allow the parties themselves to look upon the question submitted broadly and philosophically.

The Commission, therefore, does not promise to always settle questions in dispute just precisely as the operator may seem to wish or expect, but it will use its best intelligence, supported by ever increasing experience, to settle them fairly, and unless they are thus settled rancor grows and sooner or later there will be an outburst, the consequences of which will be much more costly than any advantage can amount to that has been obtained by cunning and stratagem on the one hand or brute force on the other.

The Commission insists that the way to avoid trouble is to make a right beginning and to have a clear understanding at the outset. It suggests as the first requisite that in entering into annual inter-state, state and district agreements or contracts with the Mine Workers' Union, all such agreements and contracts shall be made in writing (nothing left to conjecture or memory) and couched in language so plain that the simplest mind may grasp their full meaning, for there is nothing so true as the declaration that "half the errors and controversies which fill the world with confusion would cease to exist if men spoke and wrote with clearness and accuracy." Having made such a beginning and all the terms and conditions of every contract and agreement being clearly expressed, the Commission of the Illinois Coal Operators' Association, jointly with the officials of the Mine Workers' Union, will seek to strictly enforce their letter and spirit upon the miner and operator alike.

The following suggestions made to the coal operators of Illinois, in a circular letter addressed to them, show at one and the same time the origin of many labor troubles as well as their remedy, viz:

That before yielding to any unwarranted demand the Commission be first consulted in order that uniformity may be preserved throughout the district or State, for to yield means first to weaken and then to destroy the entire chain of agreements.

In the next place, to treat directly with the miners, thus ignoring the miners' officials, is not fair to the latter, in view of the fact that it is with them the operators have dealt in making their annual agreements.

It is natural that the miners' officials have sometimes refused to yield to the just demands of the operators, or have failed to co-operate with them because of the fear they may entertain that the too common practice of dealing directly with the miners will be pursued. Thus what wholesome influence the miners' officials would gladly exercise over the men they represent is impaired if not wholly destroyed, and hence they may too often be found clamoring for something which their intelligence and sense of fairness would not otherwise approve.

As long as we recognize the Union and deal with it, we must recognize and respect its officials and hold up their hands in rightfully enforcing their authority, for after all, the real ground for complaint against labor organizations is not that they have too much power over the men, but rather that they haven't enough when it becomes necessary to enforce compliance with

the agreements into which they deliberately entered. It is proper to say in this connection, that the miners' officials have never entered into any agreement until such agreement had been first submitted to and approved by the miners in convention assembled, and for this reason no miners should consent to be a party to any violation of the letter or spirit of such agreement.

It is now little more than four months since the Commission entered upon its duties and has sought to enforce all the terms of the different joint agreements. During that period between fifty and sixty cases of real or alleged violations of the several agreements—varying in degree and kind—have been referred to it by operators who are members of the Association, and every one of these cases has been taken up and considered either in the Commissioner's office in Chicago; at the office of the United Mine Workers in Springfield, Ill., or at the mines where the complaints originated, jointly with the officials of the United Mine Workers of America; and with three or four exceptions—and these are still under advisement—they have all been settled and that, too, I believe, to the satisfaction of both operators and miners.

The plan pursued in settling all questions referred to us is very simple and is free from all formality. Thus far representatives of the United Mine Workers and the Commissioner of the Illinois Coal Operators' Association have met by agreement and with them such miners and operators as were directly interested. Together these representatives of the two interests would hear testimony with a view of eliciting all facts bearing upon the questions involved, and unlike the custom in legal proceedings, no attempt was made to gain any advantage by confusing witnesses, but on the contrary, they were encouraged to tell the truth, in order that disputes might be settled upon their merits solely. If necessary to a thorough understanding of the case under consideration, the miners' officials, Commissioner and witnesses have gone down into the mine to see for themselves all conditions that could have any bearing upon it.

The main idea of the joint commission, it must be borne in mind, is to bring out clearly the exact facts, and, practically, when this is done, the case settles itself, for when all the points are made plain to the contending sides the one in error usually admits it before any decision is rendered, and where this is the case the settlement is the more satisfactory for reasons that must be readily apparent.

This plan has the further advantage of bringing employer and employe closer together and of establishing between them more friendly relations, at the same time that the representatives of operators and miners are afforded an opportunity of administering, without presumption or offense, some well meant and much needed advice or imparting valuable information designed to prevent future and more serious misunderstandings.

As I write a case has been settled which will serve to illustrate the difference between the present and the old plan. Yesterday an operator in northern Illinois telegraphed the Commissioner to the following effect: "Our men quit work today without warning. Claim supply of props is exhausted. This is not correct. Please take the matter up and have the men return to work at once."

I immediately sent the following message to the Secretary of the Mine Workers' Union at Springfield, Ill.: "Men have quit work without warning at ———. Please instruct local in that district to order men back to work. Wire at my expense status of affairs as your representative reports them."

The following reply was received within a few hours: "Have wired Committeeman Beattie to go to ——— at once. W. D. Ryan, Secretary, Mine Workers' Union."

This I repeated this morning to operator and asked him to report present status.

In less than two hours a message came to hand from operator informing me that men had gone back to work.

Under the old system (or absence of system) such minor cases as this would have dragged along for a week or more; miners or men in the meantime would be idle, great friction and bitter feeling would be aroused and even new troubles would grow out of the misunderstanding.

It is due the cause of truth and also as supporting the plan of conciliation adopted by the Illinois Coal Operators' Association and the Miners' Union in that State to say that the Commission has found the miners' officials prompt, courteous and fair in the consideration of every question brought before them, and the miners with whom we have come in contact have also, as a rule, yielded to our appeals where right and reason seemed to be on the employers' side. Employers, on the other hand, have accepted with proper grace and in a commendable spirit the adverse decision of their Commissioner. All this goes to show that there is a common sense businesslike plan of treating the greatest and gravest question; a plan that should appeal to and commend itself at once to the quick intellect of the

practical American business man—a plan that American employers of labor can at least afford to try without injury to any one should it here and there, or altogether, fail. But it will not fail, and the sooner all branches of industry in America are thoroughly organized and each branch or division establishes a labor commission similar to the one I have outlined for the settlement of all differences and disputes that may arise between master and man, the sooner shall we be rid of that obstruction to our commerce and that menace to our peace—the labor strike. Then all such differences and disputes can be fairly settled, because daily experience will make of such commissioners experts in their peculiar calling, who, besides the practical knowledge they may acquire in the ordinary course of their labors, will be possessed of what is always necessary in treating successfully with the laboring classes—a spirit of perfect fairness together with broad human sympathies.

These commissioners of all the branches of industry, which might include also labor commissioners for our great railroads and street railway companies as well, having by study and experience become experts, could be formed into a great central body to which would be referred grave and weighty questions such as are involved in the St. Louis Railway strike, or the builders' and contractors' lockout in Chicago; or the recent troubles in the anthracite coal field.

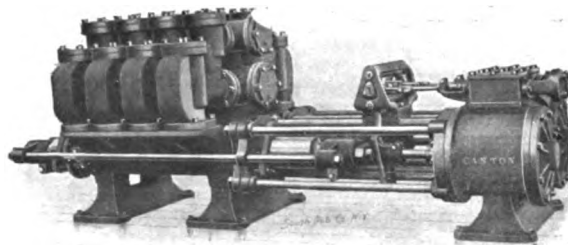
Such a body of men, representing so many and such varied interests would, collectively, possess a knowledge of every phase of the great labor question, and, having no special personal ends to subserve or financial interests to advance, it would not only enjoy public confidence in the fullest measure, but it would be hailed by wise and honest labor leaders everywhere, not only as embracing in its ranks foemen worthy of their steel, but as supplying the very influence necessary to hold in check the rabid element in their own ranks, for true labor leaders who have high and honorable aims for organized labor, well know that the danger to their cause is not from without, but rather from those noisy members of their own household who have in the past arrayed class against class, and who would today, if they could, make the breach between capital and labor an impassable gulf.

The greater then is the need for sincere and able champions of labor, and the more solemn becomes the duty of the employing class to encourage and help their employes to discriminate between true and false leaders, if the new conditions in the labor world are to be improved and utilized for the interest of every citizen and for the general advancement of civilization.

The Canton Duplex Mine Pump.

The illustration given herewith, represents a very new and approved design of mine pump, of the outside-packed plunger valve-pot pattern, constructed especially to withstand the trying conditions which must always be met with in severe mine work.

There are four single acting outside packed plungers working through externally adjustable stuffing boxes in the ends of the water cylinders. The advantage of having outside stuffing boxes is too well known to require any argument. The water cylinders are in two pieces, each having a central partition. The plungers are connected by exterior rods and cross heads, thereby making the pump double acting. The water valves, of most approved type, are located in separate chambers or "pots," designed with especial regard for quick accessibility to the valves, and placed directly over the water cylinders—as shown in the accompanying illustration.



Although, in the construction of these pumps, a special grade of material is used, they can, if desired, be furnished with the entire water ends of gun metal or other compositions suitable for the most severe requirement. Any combination of steam cylinders, either simple or compound, and with water ends suitable for pressures not exceeding 700 pounds.

Further information in regard to this pump may be obtained by addressing its manufacturers, the Canton Pump Company, Canton, Ohio.

USE OF CONCRETE IN MINING.

Its Adaptability for Lining Shafts and Drifts, and for Making Stoppings—The Methods of Putting it in Place.

By M. Marcel Habets.*

If, notwithstanding its great advantages, concrete has not hitherto been more largely employed in mining works, the reason must probably be sought in the high price of the raw materials that enter into its composition; but since slag cements have made their appearance it has been possible to obtain the most important constituent parts of this substance, equal in point of quality to natural or artificial cements, and also at a far lower price. The author has had occasion to use concrete made with blast-furnace slag in various works at the Cockerill Company's colliery, and always with complete success, models of which

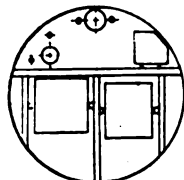


Fig. 1.

works are shown at the Paris Exhibition.

Shaft Lining.—The most important work of this nature consist in repairs to a winding shaft that were effected last year, this work being analogous to one carried out about the same period by M. Linet at the Ougree Colliery. The shaft, 14 ft. 9 in. in diameter, is divided (as shown in plan by Fig. 1 of the accompanying illustrations) into two compartments, one for winding and the other for pumping. The pumping compartment contains, 1st, Rittinger pumps worked by a pump-tree; 2nd, the delivery pipe and the pipes for leading down and back again the motive water for an underground hydraulic pumping engine on the Haniel and Lueg system; and 3rd, a cage worked by a capstan for inspecting the pumps. The winding compartment is divided, as shown in the plan, into two parts, in which the principal cages pass up and down.

This shaft is tubbed with channel-iron rings 7½ in. × ½ in. by 4 in. × ½ in. bent to the circumference of the circle; and each ring is made up of four segments connected by cast-iron fish-plates, while between these rings and the rock is a lining of boards. In some parts of the shaft this lining did not stand, and brickwork was substituted for the boards; but it did not stand any better. Inasmuch as the repairs required in a portion of the shaft shaken by working in the neighborhood were considerable, it was proposed to try concrete for lining the shaft especially on account of the excellent results obtained with this material for stoppings, and also for lining underground engine-rooms.

The concrete lining was to have a thickness of 1 ft. 8 in., with rings like those that formed the original lining embedded in the concrete towards the inside of the shaft for permitting a ready placing of the brattice. Widening out the shaft from its original diameter to that of 18 ft., in order to afford the space necessary for receiving the concrete, was only found difficult at the beginning of the work; and the first rings of the temporary lining were of channel iron, having the same dimensions as those given above. The first ring, laid as high as possible, was made tight against the rock by wooden wedges driven upwards; and this ring was also hung from the old lining, as shown in a vertical section by Fig. 2. In order to afford protection against the fall of stones from the upper part of the excavation made for widening out the shaft, pieces of timber were passed above the last ring of 14 ft. 9 in. diameter; and these pieces were bedded in the rock side of the shaft widened out to the diameter of 18 ft. and covered over with timbering as shown in the section.

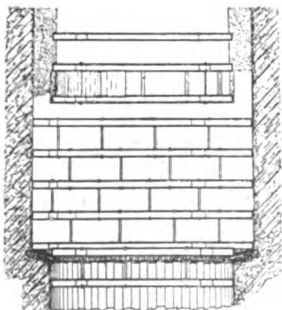


Fig. 2.

The first ring was put in place and wedged, the others being hung from it by iron hooks, and then wedged in the same manner. A pass, or section, of 33 ft. or double that length was thus excavated according as the rock was insecure or trustworthy, after which the definite concrete lining was effected. The first ring was put in perfectly level and well centered, great care being taken on account of this ring forming the base of the pass to be concreted; and then the twelve timber uprights were placed in position, having recesses in their upper ends for receiving the second ring. For keeping the latter tight against the uprights carrying it, and also for keeping the ring properly centered during the work of concreting, the two rings were connected by four tie-rods passing through the fish-plates that unite the segments.

* From a communication to the Liege section of the Societe des Ingenieurs de Liege, by M. Marcel Habets, Engineer to the John Cockerill Company, Seraing, Belgium.

The sheeting behind which the concrete was run consists of twelve iron plates, 2 ft. high, bent to the circumference and fastened by wood screws to the uprights carrying the rings, being thus easily put up and taken down. The concrete was run in behind this sheeting, and stamped energetically for driving off the air, and at the same time obliging it entirely to fill up the whole space by penetrating into the irregularities of the rock. The concrete tempered on the surface was let down in tubs; and its cost as laid was 15 francs per cubic meter (say \$1.75 per cubic yard). In that part of the shaft where before repairs were constantly required, the concrete lining, that has now been put in for more than a year, stands perfectly.

Underground Engine Room.—At the Caroline pit of the Cockerill Company's colliery a cylindrical engine room, 11 ft. 4 in. in diameter, for an underground pumping engine was lined with concrete in 1895; and since that time not the slightest fissure has shown itself. More recently (1898-99), at the Colard pit, an engine room for an underground hydraulic pumping engine was made of 14 ft. 9 in. inside diameter with concrete lining of the same thickness.

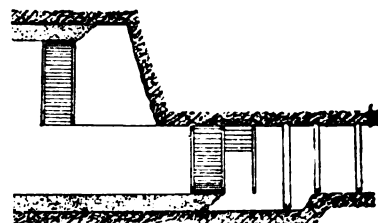


Fig. 3.

Referring to the longitudinal section shown by Fig. 3, the upper half was excavated for the whole length of the engine room, a drift being driven along the center line and then widened out, the sides being kept up by an ordinary lining. The centerings for the concreting were of deal boards, screwed together so as to be readily taken down, placed 3½ ft. apart and backed by deal sheeting 0.78 in. thick. The concrete, run in between the centering and the rock, was stamped, first vertically, but afterwards on approaching the arch horizontally; and this was the only difficult portion of the work because the stamping had to be continued until the concrete began to set. When the lining of the arch was completely terminated, the lower part of the engine-room was excavated, supports being left for maintaining the concrete arch; and the same centering that had served for the arch was reversed for lining the invert. In this case the stamping was performed vertically to as great a height as possible, and afterwards horizontally.

The cost of the concrete in place was \$1.64 per cubic yard, and the reason for the difference between this and that of the shaft lining is due to the labor, a mason and laborers being sufficient for the engine room, but workmen at high wages being required for the shaft lining.

Stoppings have also been made of concrete at a depth of 522 ft. so that they had to withstand a pressure of 16 atmospheres (235 lb. per square inch). The formula

$$e = R \left[\sqrt{\frac{T-1}{T-1-2n}} - 1 \right],$$

(in which e is the thickness, R the inside radius, T the tension admitted per square centimeter, and n the number of atmospheres) with T 33 Kilogs. per square centimeter (469 lb. per square in.), the maximum pressure to which the concrete can be subjected, and R 4 m. (13 ft.), gives 2.8 m. (9 ft. 2 in.) for e ; but, as the rocks in which the stoppings had to be put up were insecure, the thickness of the latter was increased to 16 ft. The stopping, vertical and horizontal sections of which are shown by Fig. 4, assumes the form of a truncated pyramid, and the face receiving the pressure was constituted by a brick wall, which served to keep the concrete in place at the beginning of the operation. The stamping against the sides had to be effected energetically and yet not too fast, so that the concrete might thoroughly fill up the space and form a tight joint with the rock. Three weeks after completion of the work, water was let in against the stopping, the pressure amounting to 8 atmospheres (117 lb. per square in.); and this pressure has been maintained constant ever since, without either the stopping or the joint between the rock and the concrete allowing water to pass.

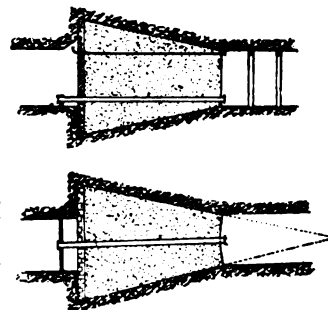


Fig. 4.

In the case of stoppings the concrete in place cost \$1.83 per cubic yard, the cost being higher than that for the engine-rooms because the site is farther from the shaft and stamping the concrete against the sides must be effected more slowly.

Lining a Fan Drift.—There remains one more application to mention, viz., the lining of the drift connecting an air-shaft with a Mortier fan. This drift had to begin horizontally with a circular section of 10 ft. diameter and terminate, inclined at an angle of 45 deg., with a rectangular section, in order to prevent the disturbance which would be caused by sudden change of direction and section, that might have exerted an injurious influence on the useful effect of the fan. This passage was made, with an insensible transition from one section to the other, by a series of templates spaced 19 in. apart, and connected by deal boards assuming the form of the inside of the concrete lining. This work was carried out with great ease and rapidity, while to form it of brick work would have been almost impossible.

The concrete used in all these works is made entirely from the products of the Cockerill Company's blast furnaces, the stone being the slag of forge pig, broken into pieces of mean $1\frac{1}{2}$ in. gauge; and the mortar was formed of granulated slag, hydraulic lime in the proportion of 5 to 1 by volume, and slag cement. The tempering of the mortar must be made by an edge-runner in order to obtain a very intimate mixture of the lime and slag; but it is not necessary to add water, a sufficiency of which is contained in the granulated slag.

The slag cement is composed of about 75 per cent. granulated slag and 25 per cent of slaked lime; and it is found that basic slags from a furnace of hot workings afford the greatest degree of resistance. Slags which are suitable for cement are distinguished by a tint varying between bluish gray and white; and chemical analysis is not necessary unless the charge contains magnesia, which is the only substance to be mistrusted. Slag containing 3 per cent. of magnesia produces cements that are liable to deteriorate in the long run, especially in the presence of salt or acid water. It is this uniform composition of the slags, readily ascertained by their appearance, that renders the quality of the cement invariable while the lime exerts but little influence on the quality of the cement.

Advantages of the System.—The following are the chief advantages of slag cement: (1) Its moderate price, which is only from 40 to 50 per cent. that of Portland cement, quality for quality. (2) The certainty of its standing and, indeed, the lime that enters into its composition is slaked at least a week before use, so that the cement can no longer contain quicklime, as may be the case with Portland cement; and slag cement may therefore be used in confidence without a previous storing for three months. (3) The resistance is at least equal to that of the best Portland cement, and it constantly increases with the duration of time. (4) The slow setting and great fineness of slag cement render its use easier, while the concrete made from it is particularly efficient especially in mines.

The concrete must be tempered on the surface, and let down into the underground workings where it is to be employed. If a too quick setting cement be used, there will be a commencement of setting during the letting down, and the concreting will not be effected so well nor with so good a result. The concrete employed at the Cockerill Company's colliery is compact, leaving no interstices, a condition specially necessary for stoppings that have to keep back water and also for linings that must be of great strength. For one volume of concrete, 0.75 volume of granulated slag and 0.15 volume of hydraulic lime were mixed in the edge runner; and, during the operation of grinding, the volume was found to be reduced by one-half, giving the proportion of ground slag and lime 0.45, cement 0.1, and broken slag 0.8, making a total of 1.35, while after ramming, this figure became reduced to 1. Experience has shown that the proportion of 2 cement mortar to 3 of broken stone is that which stands best; and concrete mixed in the edge runner costs 7.50 francs per cubic meter (\$1.35 per cubic yard).

In addition to the economy, the advantages of concrete over brickwork are enormous, the strength being far greater. The

minimum resistance of concrete to crushing strain may be put at 300 kilograms per square centimeter (4,226 lb. per square inch), which is far superior to that of the best brickwork, so that concrete may be adopted in all confidence for stoppings and other works at a depth where brickwork can no longer be employed. In fine, the great facility with which concreting can be performed; the mobility of the concrete, which permits it to form an integral whole with the sides, by penetrating into all the irregularities of the rock and giving the most convenient form to the work that has to be executed; and lastly, the absence of joint—all these advantages combine to recommend concrete for mining work generally, as is abundantly proved by the work carried out at the Cockerill Company's colliery.

COAL OUTCROPS.

The Relation Between the Thickness and Quality of Coal Beds at the Outcrop and at Depth.

By Charles Catlett, Staunton, Va.*

Probably no one has had occasion to examine an undeveloped coal property without hearing some hopeful or interested party insist that the bed will improve when opened some distance under cover. When the bed is already in good condition, the opinion is usually advanced that the same character may be expected, at least to the bounds of the hopeful individual's holdings. My attention has been called in this way to the extent to which a bed is affected by its outcrop at the surface; and having had opportunity to examine a number of openings immediately at the surface, and also a short distance under cover, I submit some observations bearing on this question.

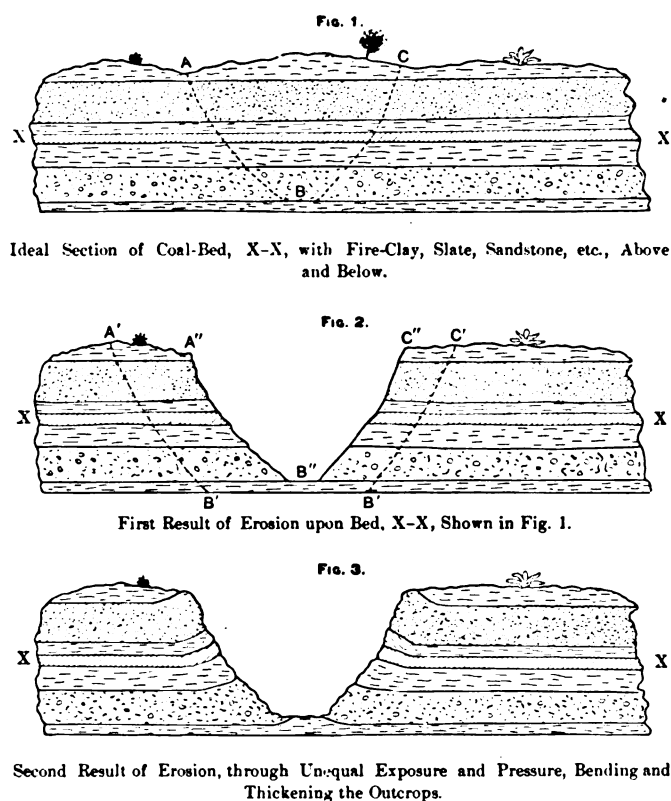
Whatever may have been the original variations, we may assume that coal-basins presented in comparatively modern times approximately parallel beds interstratified with fire-clay, slate, sandstone, etc., as represented by Fig. 1.

Under the effect of erosion, Fig. 2 would be formed.

It is obvious that along the line *A B C* in Fig. 1, the beds exist under conditions differing from those at *A' B' C'* or again at *A'' B'' C''* in Fig. 2, in their exposures to atmospheric agencies, pressure and erosion. The effect of the first is to decompose and soften many of the strata; of the second, when presented unequally, to cause the move,

ment of such material as was at all plastic towards the point of least pressure; and of the third, to remove the strata in whole or in part. It is obvious that the pressure is not as great at or near the outcrop as it is some distance under cover; and the tendency, therefore, would be to increase the thickness at the former point, and to give a result which might be represented by Fig. 3, in which each stratum is elevated by the sum of the thickening of all the strata beneath it. The result is exaggerated in the figure. It is usually not conspicuous, since the material thus forced to the surface is peculiarly subject to erosion and removal, so that the effect on the level of the various strata is small, and is often offset by local conditions. Yet it exists; and in places where the beds of coal are underlain by thick beds of plastic fire-clay, they commonly show a dip from the outcrop, owing to the thickening of the fire-clay bed at that point. In illustration of the changes which may be expected to occur from the outcrop, or the first point where the full section of the coal is disclosed under an apparently undisturbed roof, to a point some distance from the outcrop, the following typical sections are furnished. They represent a wide territory, and come from Virginia, West Virginia, Kentucky and Alabama:

*A paper read at the Canadian meeting of the American Institute of Mining Engineers, August, 1900.



I.		50 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
81. coal,	33	24. coal.	33
1.5 sandstone,		2. hard coal.	
14. coal,		7. coal.	
3. coal and fire-clay,		1.5 sandstone.	
9. coal,		14.5 coal.	
54. coal,		2. coal and fire-clay.	
4.5 partings,		10. coal.	
58.5	58.5	57.5 coal.	
		3.5 partings.	
II.		50 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
18.5 coal,		21. coal.	
parting,		parting.	
9. coal,		10. c. al.	
1. sandstone (bituminous),		1.25 bitumin. sandstone.	
14.5 coal,		15. coal.	
1. slaty material,		1. slaty coal.	
15. coal,		12. coal.	
57. coal,		58. coal.	
2. partings,		2.25 partings.	
59.	59.	60.25	60.25
III.		80 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
3. draw slate,		3. draw slate.	
19.5 coal,		19.5 coal.	
0.5 bituminous slate,		0.5 inferior coal.	
10. coal,		14. coal.	
1. sandstone,		1.5 sandstone.	
18. coal,		19. coal.	
1. fire-clay,		1. fire-clay.	
21. coal,		16.5 coal.	
68.5 coal,		69. coal.	
5.5 partings,		6. partings.	
74.	74.	75.	75.
IV.		50 ft. from Surface.	
Outcrop.	Inches.	Inches.	
6.5 coal,		5. coal.	
0.25 parting,		1. bitumin. slate.	
11.25 coal,		2. coal.	
1. sandstone,		1.75 hard coal.	
10. coal,		10. coal.	
1. slate,		1. sandstone.	
4.5 coal,		14. coal.	
2.25 fire-clay,		0.5 slate.	
3.5 coal,		5. coal.	
6. fire-clay,		4. fire clay.	
6. coal,		3.5 coal.	
41.75 coal,		6. fire-clay.	
10.5 partings,		6. coal.	
52.25	52.25	47.25 coal.	
		12. partings.	
V.		50 ft. Inside.	
Surface—no roof exposed.	Inches.	Inches.	
16. coal,		20. coal.	
9. slate,		8.5 slate.	
17. coal,		18. coal.	
38. coal,		38. coal.	
9. slate,		8.5 slate.	
42.	42.	46.5	46.5

The average of 13 sections in the mine working this seam shows 35.5 inches coal and 15.3 inches slate.

VI.		15 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
14.5 coal,		14.5 coal.	
0.5 slate,		2. slaty and bony coal.	
5.5 coal,			
0.5 slate,		9. coal with bony streaks.	
5.5 coal,		1.5 slate.	
0.5 slate,		15.5 coal.	
17. coal,			
42. coal,		41. coal.	
1.5 slate,		1.5 slate.	
43.5	43.5	42.5	42.5
VII.		80 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
6.5 coal,		11. coal.	
0.5 slate,		0.5 slate.	
11. coal,		6. coal.	
3. fire-clay,		3. hard fire-clay.	
2. coal,		1. coal.	
10. coal and slate,		7. coal and slate.	
14. coal,		12.5 coal.	
33.5 coal,		30.5 coal.	
13.5 partings,		10.5 partings.	
47.	47.	41.	41.

VIII.		66 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
24. coal,		21.5 coal.	
1.5 slate,		1.5 slate.	
1.5 coal,		0.75 coal.	
8. slaty coal,		0.75 slaty coal.	
27. coal,		29. coal.	
52.5 coal,		51.25 coal.	
4.5 partings,		2.25 partings.	
57.	57.	53.5	53.5
IX.		100 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
23. coal,		27. coal.	
parting,		0.75 parting.	
24. coal,		17. coal.	
1. slaty coal,		1. parting.	
5. coal,		4. coal.	
52. coal,		48. coal.	
1. parting,		1.75 partings.	
53.	53.	49.75	49.75
X.		250 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
13. coal,		13. coal.	
1.5 slate and sandstone,		1.5 slate and sandstone.	
2. coal,		5. c. al with small hard streak.	
1. slate,		0.5 slate.	
2.5 coal,		9. coal.	
14. slate and coal,		3. slate and coal.	
4. sandy slate,		24. coal.	
24. coal,			
41. coal,		41. coal.	
20.5 partings,		5. partings.	
61.5	61.5	46.	46.
XI.		50 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
13. coal,		11. coal.	
1. slate,		3. cannel coal.	
3. coal,			
1.5 slate,		6. slate.	
0.5 coal,		6. coal.	
4.5 slate,			
2.5 coal,		11.5 sandy slate.	
4.5 coal and slate,		27. coal.	
8. sandy slate,		8. cannel coal.	
31. coal,		14.5 coal.	
6. cannel coal,			
12. coal,		69.5 coal.	
70.5 coal,		17.5 partings.	
19.5 partings,			
90.	90.	87.	87.
XII.		15 ft. from Outcrop.	
Outcrop.	Inches.	Inches.	
14.5 coal,		14.5 coal.	
4. slate,		4. slate.	
80. coal,		29. coal.	
6. slate,		8.5 slate.	
13. coal,		16.5 coal.	
0.75 coal and slate,		1. slate.	
4. coal,			
28.5 0.5 slate,		21. coal.	
14. cannel coal,			
10. coal,			
85.5 coal,		80.5 coal.	
10.75 partings,		13.5 partings.	
96.25	96.25	94.	94.

The average of the mine working this seam is between 44 inches and 46 inches clean coal.

In summary: 6 sections out of 13 show an increase in coal-thickness of 6.45 per cent. on being driven under cover; 7 sections out of 13 show a decrease of 4.75 per cent. in the coal-thickness on being driven under cover; 6 sections out of 11 show a decrease of partings, on being driven under cover, of 30.24 per cent.; 5 sections out of 11 show an increase in partings, on being driven under cover, of 27.46 per cent.

An examination of these sections will disclose a marked similarity between the seam at the surface and when opened a reasonable distance under a solid top; and this was borne out by numerous other examples which it is not necessary to give. Beds will vary from point to point, and will present, often without apparent reason, marked irregularities; but observation of these sections has convinced me that the changes due to the nearness of the surface *alone* can be recognized and allowed for, and that it is possible to form from the outcrop a very nearly accurate idea of what may be expected 50 or 60 or 75 feet under the top.

I briefly summarize the changes which may be expected. A very soft, sooty material, called by the miners "mother-coal," may pass, in that distance, into a coherent but friable material. It is usually exceedingly pure. Hard streaks in the coal are emphasized at the surface; and a material which is coal, but is obviously high in ash, may be found, owing to the increase of volatile and oily material, to become often of fair quality, on driving a short distance under cover, and be classed in a section at that point as pure coal. A slaty material which is very black and friable will, as a rule, pass into inferior coal, in the distance named; and, when in small quantities, would probably, in a section 50 feet from the outcrop, be described as bony coal. Hard, undecomposed gray slate, on a well-defined bed, may be expected to continue as such without, necessarily, an increase or decrease within the distance named. A plastic slate or a fire-clay, existing as a portion of the coal-bed, may usually be expected to thin very considerably within a short distance, as its section at the surface is, in nearly all cases, increased by the reduction of pressure at that point.

I would be glad to hear from other members of the Institute on this point, as a confirmation of these observations would make it very much easier and less expensive to prospect a coal-property, and would often permit what, in my judgment, is far more desirable than to drive upon the seam under cover, namely, the making of a larger number of openings over a greater extent of outcrop.

TRADE NOTICES.

The Calumet & Hecla Mining Co. are using 67 Austin separators purchased from The Austin Separator Co., of Detroit, Mich.

The Harrisburg Foundry & Machine Works have recently installed a Cross Oil Filter made by Burt Mfg. Co. of Akron, Ohio.

The Paris agent of the Rand Drill Company reports that all the compressors and drills which were on exhibition at the Exposition have been sold. The large Corliss Compound Compressor, which supplied the compressed air to all the American exhibits at Vincennes, was purchased by the firm of Messrs. J. & A. Niclausse, the manufacturers of the famous Niclausse water tube boilers, by whom it is to be used for the operation of pneumatic tools in their extensive establishment.

The Homestake Mining Co., of Lead, So. Dakota, has placed an order with Gates Iron Works for 10,000 special stamp shoes. This order is unique in the fact that it is probably the largest order for stamp shoes ever placed by one company. Gates Iron Works has been supplying the Homestake Company with its shoes for several years. The trade was established under severe competition on the point of quality. Gates Iron Works has been successful in producing stamp shoes combining great strength and hardness. The order will require 51 freight cars to transport it.

The Bethlehem Steel Company recently received an order from the Anaconda Copper Mining Co. of Anaconda, Mont., for a hollow-forged fluid-compressed steel shaft 17' 10" long and 15½" to 20" diameter with a 7" axial hole, to replace a shaft which broke in the hoisting engine of the mine, necessitating a shut-down until the new one could be received. The new shaft was taken in hand under emergency conditions and finished complete within fourteen days from receipt of order, which was two days in advance of contract agreement. It weighed about 12,000 lbs., and, on account of the urgent nature of the case, was shipped to Anaconda by express in a special car.

The A. W. Cadman Mfg. Co., the oldest brass works in Pittsburgh, has written us as follows: "Our Indestructible Blow Off Valve is meeting with general approval in all sections of the country. We have recently equipped several of the largest manufacturing in the United States with this design of valve, and judging from the general influx of orders and inquiries we expect quite a large demand for them this winter. Users of babbitt metal are beginning to realize that Cadman's Aluminum Babbitt Metal 'Acorn Brand' is the best and cheapest bearing metal in the market. Many of the largest railroad companies find it by far the best metal obtainable for use in their locomotive piston rods, and valve stems. We are constantly marketing new features in steam specialties, and probable users would do well to bear us in mind when in need of such appliances."

The management of the Chicago, Burlington & Quincy Railroad has contracted with the Baldwin Locomotive Works for thirty more new freight engines, to be delivered next March. They will be alike in construction, each having three pairs of drivers and a set of leading and trailing trucks. The driving wheels will measure sixty-four inches in diameter and the truck wheels thirty-seven inches in diameter. The dimensions of the cylinders will be 24 by 24 inches. The engines will differ from the average freight train puller in having wider and shorter fire-

boxes. The fireboxes will be 7 feet long and 6 feet wide, and their heating surface, combined with that of the tubes, will be about 2,498 square feet. The weight of each engine on its drivers will be 120,000 pounds. The leading trucks will weigh 16,000 pounds and the trailing trucks 24,000 pounds. Unloaded, each tender will weigh about 38,000 pounds. It will have a capacity of 5,000 gallons of water and between nine and ten tons of coal.

Brownell & Company, of Dayton, Ohio, manufacturers of steam boilers and engines have, in the last few months, added to their equipment so as to increase their capacity 50%, their capacity now being about 2,500 steam boilers and 600 steam engines per year. This concern has grown steadily from year to year and is now considered one of the foremost in the United States in the manufacture of their product. Having the latest improved tools their workmanship is not excelled and as they carry large stocks of materials, they are in a position to make shipments with a reasonable degree of promptness. This feature will be quite beneficial to themselves as well as their customers during the next six months on account of the overcrowded condition of rolling mills due to the orders placed since the election. Their Sales Department is well equipped and is pleased, at all times, to furnish catalogues and estimates to prospective buyers.

The establishment of the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., is a very busy place these days. The enormous demand for its safety water columns has pushed its manufacturing facilities to the limit, but by running the factory day and night the company is able to make prompt shipments. In addition to the orders of from ten to one hundred columns each reported last month, shipments have been made as follows, besides several hundred others of three and less: Akron Brick & Tile Co., 6; J. C. McNeil Co., 5; Canton Steel Co., 6; Gambrius Stock Co., 4; Mechanical Rubber Co., 6; L. Hosler Brewing Co., 9; N. Sohler & Son, 4; Kilbourne & Jacobs Mfg. Co., 6; Davis Sewing Machine Co., 4; G. H. Holmes Defiance, 4; The Robinson-Merrill Pottery Co., 7; Knowles, Taylor & Knowles, 7; The Beckett Paper Co., 4; The Morris & Guild Co., 6; The Royd Sewer Pipe Co., 6; Newark Water Co., 4; The Crown Fire Clay Co., 7; The Buckeye Engine Co., 5; Ohio Hospital for Epileptics, 6; National Fire Proofing Co., 4; The Luhrig Coal Co., 8; The Aetna S't'd. Works, 6; Warren Water Co., 5; Vulcan Iron Works, 8; Phila. & Reading Coal & Iron Co., 4; Babcock & Wilcox Co., 6.

An Emergency Box.

In the December issue of MINES AND MINERALS, Dr. M. J. Shields of Jermyn, Pa., called attention to the advisability of organizing First Aid or Emergency Societies for service in case of accidents about the mine and while waiting for the arrival of a physician.

An essential part of the equipment of such a society is an Emergency Box, such as is illustrated herewith. These outfits



are made by C. Troutman Co., manufacturers of mine supplies and mining tools and jobbers in hardware, iron, steel, etc., 1803 Carson St., Pittsburgh, Pa.

The case here shown contains the following articles: 1 Tour-niquet for stopping the flow of blood, 1 Bottle Carbolic Lotion for washing wounds, bruises, etc., 1 Cake Surgeon's Soap, 6 Roller Cotton Bandages for binding up cuts, etc., 3 Triangular Cotton Bandages for Slings, 1 Box Adhesive Plaster for drawing wounds together, etc., 1 Bottle Aromatic Spirits of Ammonia to be used in case of fainting, 1 Large Bottle Carron Oil for burns, 4 packages Absorbent Cotton, 1 Pair Scissors, 1 Paper Pins. These are put up in a neat japanned tin box, size 8 x 12 in., 6 in. deep, with handle, and with lock and two keys. This accident case is specially designed as a first help in case of injuries received in mines, lumber camps, factories, furnaces, mills, rail roads, etc., etc. Full plainly worded directions accompany each case, so that any one of ordinary intelligence can quickly and successfully apply every article. This is not a physician's case but is intended to be used by any one to save life and ease pain before the physician arrives.

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ANTHRACITE COAL CHANGES.

THE passage of the Pennsylvania Coal Company from the camp of the individual operators to that of the railroad corporations not only sounds the death knell of the Delaware Valley and Kingston Railroad, or as it was commonly called, the Individual Operators' Road, but it probably also marks the beginning of a new era in anthracite history. It may not mean that the individual operator is also doomed, but it certainly increases and makes paramount the influence of the anthracite coal carriers.

This latest transfer in management is but the culmination of a series of transfers which began with the formation of the Temple Iron Company about two years ago. Since that time, nine or ten individual collieries have passed under the control of the Ontario and Western Railroad, or interests allied with that road, the latest acquisition being the Pancoast Coal Company, operating at Throop, Pa. Within the past month the Hillside Coal & Iron Company, which is the coal department of the Erie Railway, has also acquired three collieries of the Butler Mining Company, at Pittston. This leaves only about twenty-five individual collieries with an output of about 12,000 tons per day in the Lackawanna and Wyoming fields, and rumors are very prevalent that this number will be considerably decreased in the near future. What effect these recent movements will have on the individual operators who retain control of their collieries it is difficult to tell. Whether they will eventually sell also, or whether they will be able to make such shipping and sale arrangements for their product as will be satisfactory, cannot at present be more than conjectured.

The Pennsylvania Coal Company was one of the oldest organizations in the anthracite region, having been founded in 1838, and its management throughout has been conservative and businesslike. The fact that its stock brought \$276 per share, par value \$50, while the company retains assets to the value of \$10,000,000, or 200% additional, shows that the property is still a valuable one, and those conversant with the matter believe that the Erie Railway, the combination of financiers in New York City, or whoever may be the real purchaser, has secured an exceptionally good bargain, even at the high price paid for the property.

MINING INVESTMENTS.

FOR some time past a great deal has been said about the surplus of money throughout the country, about the low rates of interest which money is bringing, and, particularly in the East, about foreign investments of American capital.

The opportunities for making profitable mining investments were never better than at the present time. Mining is now being prosecuted upon a much higher plane than it was even 10 years ago, and, although it cannot be said to have yet reached the position of an exact science, it is a business which if properly carried on can be counted upon to bring good returns for the money invested in it.

There is probably no State or Territory between the Eastern foothills of the Rocky Mountains and the Pacific Coast, but that can offer paying mines of gold, silver, lead, copper, etc., to absorb at least a portion of the surplus money which now seems to be going begging. Indeed the territory in which profitable mining investments can be made is by no means restricted to the above limits, for Michigan, and Minnesota offer copper and iron properties, Pennsylvania, Ohio, Illinois, West Virginia, Alabama and 38 or more of the states of the United States have undeveloped coal fields awaiting capital for their development; while the clay, building stone and many similar industries suggest fields for exploitation and investments which are as yet practically untouched.

Why, then, is not more of this surplus wealth put into the ground for safe keeping? The answer almost invariably given is that mining investments are too risky.

There is an element of uncertainty about every investment, and mining, of course, shares this uncertainty with all other kinds

of business, but, as we have frequently pointed out through these columns, the trouble is not nearly so often with the investment as with the investor, who in very many cases has himself to blame for the foolish and unbusinesslike way in which he has disposed of his money.

The best of judgment and business sense, and years of experience, cannot fathom the secrets in the bosom of mother earth with any degree of certainty, although science has done a great deal in recent years to assist the real seeker for knowledge. On account of this necessary uncertainty, the profits from mining should be larger than from some other forms of investment where the results can be predicted.

A mining investment is no more a gamble than is any other investment, excepting when the investor is a gambler who attempts to get something for nothing. There is a vast amount of unmined gold in the world, but there is an even greater amount of "fool's gold."

Mining should not be blamed, as it usually is, for the lack of foresight, judgment, and ordinary business sense, which are no less fatal to mining than to any other business. It is not fair to charge up against legitimate mining the losses that have undoubtedly been suffered by many investors, but which are due very largely to sheer stupidity and in some cases laziness of the investor, who does not take the trouble to exercise any personal oversight over the investment. As fair would it be to charge up against the farming industry all of the losses of the stock exchange.

A distinction must be made between bona fide investments and flyers as they are commonly called. No one should attempt the latter unless he can afford to lose what he puts into it, and in case of that loss the less he says about it the better wisdom does the loser display.

A thing is usually worth about what it sells for and a share of mining stock that sells for 5 cents is usually worth 5 cents whether its par value is quoted as \$1 or \$5.00. This brings up the question so often asked, why are mining companies so often over capitalized, and why, for instance, does a company issue 1,000,000 shares at a par value of \$1.00 per share and which are sold at 1 cent per share, instead of 1,000 shares to be sold at their value of \$10.00 thus giving the same working capital as the million shares at 1 cent per share. Two reasons can probably be assigned for this. In the first place 1,000,000 shares sound better than 1,000 and 1,000 shares at 10 cents per share are much more easily sold than 1 share at \$100. In the second place it is undoubtedly true that a mine may be worth \$1,000,000 after development which before development is not worth \$100 or \$1,000, and if the money raised by selling these low priced shares is put into honest development work the chances are that the true value of the mine and the par value of the stock will be realized, assuming, of course, that the property has been well selected and carefully managed.

The claim is frequently made that an investor in mining stocks or in a mining property is dependent solely upon the judgment of some one else, and that he does not have it within his own power to thoroughly investigate the subject. This objection is valid to a certain extent, but to not nearly the extent usually taken for granted. Many mining properties are located at a considerable distance from the centers of population and in many cases they are inaccessible for the ordinary traveler. It is also true that many an investor is not competent to decide the technical questions that come up in connection with a mining purchase any more than he is the details of any manufacturing enterprises in which he puts his money, and he must of necessity depend upon expert opinion in this particular. There is, however, much that can be found out by any intending purchaser. Let him first find out whether the particular property in which he would invest, or at least the district in which it is located, has been described in any reliable technical journal; if the region supports a local paper he can find out much about it in this way as, for instance, whether developments have progressed sufficiently to attract mineral surveyors, assayers and engineers, whether it is tapped by a rail-

road, whether banks and assay offices have been established, and similar practical questions which will appeal to any business man. To be sure the statements of local papers must usually be taken with a grain of salt, but no more so than statements in the more pretentious metropolitan papers, and every business man in reading his newspaper makes corrections and allowances in all its statements and would not think of making an investment simply upon newspaper statements. If at all possible the district should be visited and the general business conditions which any business man can appreciate should be studied at close range. If such a personal investigation is satisfactory then have a closer examination made by some professional mining man and expect to pay him well for his report. Do not think that the value of a report can be gauged by its length or by the number of technical, geological and other scientific terms that it includes. If it is filled with technical terms and theorizes at length upon all subjects connected or unconnected with the point at issue it will be safe to get another opinion as in nine cases out of ten the verbose writer and the glib talker are simply using these names to gloss over or cover up a very little information.

There are two classes of persons through whose influence money is being constantly lost in mining investments. First, the uninformed, well intentioned, honest man, who induces his friends to invest money in properties solely upon his judgment upon a subject of which he is perfectly ignorant. Second, the informed, dishonest man, who is a shark or sharper. Although it may seem unfair to place these two classes of men in such close connection, their influence upon the good name of mining is the same, and if anything the influence of the former is much worse than that of the latter. The friends of the honest man who have lost money in a mining venture, since they know him to be perfectly sincere and honest, conclude that all mining must be dishonest and thenceforth give everything of a mining character a wide berth, and in general use all their influence to keep others from making similar investments. On the other hand the man who has been fooled by a sharper, and finds that he has bought a gold brick, is not apt to lay it up against mining and is usually only too willing to keep quiet about it.

Men fooling sharks will exist until very near the time of the millennium, and mining must expect to support its share of the general family. Mr. Barnum knew mankind very thoroughly when he said that they liked to be fooled. Nothing evidences this more strongly than that there are still concerns which apparently are doing a flourishing business in the sale of divining rods, electrical mineral indicators, etc., etc. No one section seems to have a monopoly in the use of these charmed mineral finders for here in Pennsylvania we find a concern advertising and selling apparatus costing from five dollars to several hundred warranted to find any known mineral, the apparatus being provided with different forms of hooks which are attached to the same line.

Whenever the investing public can be induced to use ordinary common sense and business prudence in making its mining investments the cry that such investments are a natural and legitimate way of losing money will cease.

CANADIAN IRON ORE.

ACCORDING to a recent issue of the *Cleveland Leader*, the first cargo of iron ore ever received at a port on the south shore of the great lakes from Canada was recently unloaded at Ashtabula, Ohio, the ore having come from Michipicoten, Ontario. This shipment was probably something of an experiment, but it may be the entering wedge of a movement which will be of considerable importance and value to the users of iron ore along the south shore of the lakes, and may figure in the near future as one of the elements in the lake iron ore trade.

Although the supply of iron ore in the Michigan and Minnesota field is practically inexhaustible, a large part of this is of the non-bessemer grade, and if the Canadian ores should prove to be

of bessemer variety they may exert either a controlling or at all events a disturbing influence upon the prices for ores coming from the older ranges. There are but a limited number of furnaces in Canada, and should the Canadian deposits develop as the reports given out about them promise that they will develop, it is not at all probable that the Canada iron industry can absorb the ore output.

It is said that those who are exploiting the Michipicoten fields hope to compete with the American iron ores, depending upon the lower wages paid in Canada to offset the tariff charges upon iron ore.

COAL AND METAL MINERS' POCKET BOOK.

THE Sixth Edition of the Coal and Metal Miners' Pocketbook, just received from the printer and which will be ready for distribution as soon as the requirements of the International Copyright Law have been complied with, about January 1, 1901, is in every way a new book and not a reprint of the Fifth Edition.

So much additional data has been gathered since the issue of the Fifth Edition in 1893, that in order to keep the Pocketbook within a reasonable size and still to bring it up to date, it was found necessary to rewrite nearly all of the previous edition. By thus rewriting, and by careful selection of new material, it has been possible to include practically all that was in the Fifth Edition, and also to add as much more entirely new matter, without materially increasing the size of the book.

Every portion of the book has been revised and improved, but the following are some of the entirely new sections in this edition:

Stope Books; Railroad Curves; Hydraulics; Pump Machinery; Electricity; Diamond Drilling; Timbering; Explosives; Machine Mining; Hoisting; Haulage; Ore Dressing and Preparation of Coal; Sizing and Classifying Apparatus; Handling of Materials.

The glossary of mining terms contains over 2,300 words and it is thought to be the most complete mining glossary ever published. The book has been printed from entirely new plates and the illustrations are all from new drawings and cuts.

A review and criticism of the contents of the Pocketbook by the well known mining engineer, Mr. William Griffith, will be found among the Book Reviews in a subsequent number of MINES AND MINERALS.

A circular descriptive of the Pocketbook and showing sample pages will be sent to every subscriber to MINES AND MINERALS, and a copy of this circular will be mailed free to any one addressing MINES AND MINERALS, Scranton, Pa. Further particulars concerning the Pocketbook will also be found upon advertising page 31 of this issue of MINES AND MINERALS.

The following special offer is made to subscribers to MINES AND MINERALS.

SPECIAL OFFER.

To Any Subscriber to MINES AND MINERALS, whose subscription is paid six months, or more, in advance, and who sends us a new prepaid subscriber for MINES AND MINERALS, we will send a copy of *The Coal and Metal Miners' Pocketbook, Sixth Edition, Free.*

Any Subscriber to MINES AND MINERALS, whose subscription is paid six months, or more, in advance, can buy one copy of *The Coal and Metal Miners' Pocketbook, Sixth Edition, for \$2.00.*

New Subscribers to MINES AND MINERALS (subscription price \$2.00 per year to any part of United States, Canada, or Mexico, and \$3.00 per year to other parts of the world) can secure a copy of *The Coal and Metal Miners' Pocketbook* by remitting \$2.00 in addition to the subscription price.

Special attention is also called to the fact that after January 1st, 1901, all special premiums heretofore given with MINES AND MINERALS will be discontinued, and the Coal and Metal Miners' Pocketbook will be the only premium offered.

Antidote for Lead Poison.

Barley water is recommended as a curative in case men are "leadied" through working in a mine or smelter.

Sulphuric acid is an antidote for lead poisoning, and one drop in a glass of water should afford relief.

Book Review.

THE PRODUCT OF PETROLEUM, by F. H. Oliphant, 297 pages.

PRODUCTION OF NATURAL GAS, by F. H. Oliphant. 30 pages.

AMERICAN AND FOREIGN IRON TRADE IN 1899. James M. Swank, 54 pages.

PRODUCTION OF ASPHALTUM AND BITUMINOUS ROCK, by E. W. Parker, 18 pages.

BULLETIN No. 65, PENNSYLVANIA DEPARTMENT OF AGRICULTURE. Farmers' Library List.

BULLETIN No. 63, PENNSYLVANIA DEPARTMENT OF AGRICULTURE. A Course in Nature Study for use in Public Schools.

UNITED STATES GEOLOGICAL SURVEY, by Chas. B. Walcott, Director, Washington, D. C. Mineral products of the United States 1890-1899.

FIFTH ANNUAL REPORT OF THE DEPARTMENT OF AGRICULTURE OF PENNSYLVANIA. John Hamilton, Secretary of Agriculture, Harrisburg, Pa. 368 pages.

REPORT UPON EXAMINATION OF RESERVOIR SITES IN WYOMING AND COLORADO, by Lieutenant-Colonel Hiram M. Chittenden, U. S. A. 106 pages. Published by the War Department, Washington, D. C. Illustrated.

JOHNSTOWN CENTENNIAL. 1800-1900. Jas. M. Swank. Pamphlet 14 pages. A History of Early Iron Enterprises in Cambria, Somerset, Westmoreland, and Indiana Counties, prepared for the Johnstown Centennial.

ANNUAL REPORT OF THE STATE GEOLOGIST OF NEW JERSEY FOR 1899. Report on Forests. 328 pages copiously illustrated. J. C. Smock, State Geologist.

BULLETIN OF THE DEPARTMENT OF LABOR, November, 1900, Washington, D. C. 202 pages. Articles on the following subjects: The Betterment of Industrial Conditions; Employers' Liability; Condition of Railway Labor.

GEOLOGICAL AND NATURAL SURVEY OF MINNESOTA. Vol. 5. Structural and Petrographic Geology of the Taconic and Archean, by N. H. Winchell, State Geologist, Minneapolis, Minn. Illustrated by six plates and 55 figures. 1026 pages.

BRITISH COLUMBIA MINING RECORD, SUPPLEMENT, Vancouver, B. C. 112 pages, price 25 cts. This is a well gotten up supplement or annual number containing excellent views of British Columbia Mines and a number of interesting descriptive articles.

CANTOR LECTURES ON THE NATURE AND YIELD OF METALLIFEROUS DEPOSITS, by Bennet H. Brough, London, England. Pamphlet, 54 pages. This pamphlet contains four lectures as follows: I.—Deposits in which ores of the useful metals are met with—Beds, veins and masses—Classification of ore deposits—Methods of mining formerly employed—Recent improvements. II.—Sources of the world's supply of gold and silver—Principal mines now worked—Future resources. III.—Sources of the world's supply of iron ore—Principal mines now worked—Future resources. IV.—Sources of the world's supply of copper ore—Principal mines now worked—Deposits of the ores of lead and other metals.

GEOLOGICAL SURVEY OF NEW JERSEY. Annual Report for the year 1899. J. C. Smock, State Geologist, Trenton, N. J. 192 pages and map. In addition to the administrative reports, the bulletin contains four parts as follows: Part I, Paleozoic Formations, by Stuart Weller. Part II, Artesian Wells, by Lewis Woolman. Part III, Chlorine in the Natural Waters, by William S. Myers. Part IV, The Mining Industry, by George E. Jenkins, C. E. This latter portion reports a considerable activity in the iron mines of the State during 1899, and notes the reworking of a number of mines which had been previously closed. It also calls attention to the fact that the concentration of the large quantities of lean ore have received closer attention, and describes in some detail a number of well-known New Jersey iron mines. Following this are analyses of New Jersey iron ores, and notes on New Jersey copper mines by H. B. Kummel. The report on mineral statistics gives the output of iron ore during 1899 as 300,757 tons, and of zinc ore as 154,447 tons.

A MANUAL OF ASSAYING, by Alfred Stanley Miller, Professor of Mining and Metallurgy, University of Idaho. Published by John Wiley and Sons, New York City. 91 pages, illustrated. The work of fire assaying for gold, silver and lead is described, and apparatus used illustrated, in order of actual operations. The assay of an ordinary silicious, gold-silver ore is first taken up and the different necessary operations briefly described in order that the student may have no difficulty in understanding the methods of assay of complex ores given farther on in the book. After description of fire assay for lead follow notes on fire-assay operations in general and short chapters on fluxes and reagents

and slags. Assay of refractory ores for gold and silver with tables of crucible and scorification charges from standard works on assaying is followed by brief descriptions of amalgamation and chlorination assays. This little manual will no doubt be of assistance to many for use in connection with standard textbooks but it lacks sufficient detail for the inexperienced.

TENNESSEE COAL, IRON & RAILROAD COMPANY. Description of Plants and Mines with Illustrations. Published by the company at Birmingham, Ala. 174 pages. This is a handsomely prepared monograph, 12 by 9½ inches in size, containing very excellent illustrations of the numerous properties and mines belonging to this well known company. The Tenn. Coal, Iron & R. R. Company supplies the trade with domestic, steam, gas, blacksmith, and coke coal, furnace and foundry coke; and it is the principal source of supply for nearly every railroad in the South. It is also a large producer of iron and steel of various grades. The Alabama and Tennessee irons have largely replaced Scotch pig in American foundries, and these irons are also coming into use in English and Continental mines as well. The Tennessee Coal, Iron & R. R. Company makes a specialty of basic iron available either for the Siemens-Martin basic open hearth or the basic Bessemer process.

Some idea of the capacity and extent of the operations of this Company is gotten from a recapitulation given in this monograph. The Tenn. Coal, Iron, and Railway Company controls 30 coal mines with a yearly capacity of 5,700,000 tons of coal; 3,732 coke ovens with a yearly capacity of 1,800,000 tons of coke, and 29 iron mines having a capacity of 2,640,000 tons per year. It has also 20 blast furnaces with a yearly capacity of 1,250,500 tons of pig iron. Its steel works are capable of producing 312,000 tons per year, and its bessemer rolling mill product is 60,000 tons, while its iron foundries have a capacity of 24,000 tons per year. The total output of the company for 1899 was 7,809,927 tons.

To haul this gigantic output of raw material and finished product would require over 300,000 railroad cars, making a train over 1,500 miles long. The Company's product of pig iron in 1899 represented nearly five per cent. of the entire output of pig iron in the United States and 1½ per cent. of the output of the entire world. The Company's coal output represented over 2 per cent. of the output of bituminous coal and 1½ per cent. of the entire coal output of the United States in 1899. The output of the Company's Alabama Mines was 47 per cent. of the total coal production in Alabama, and its Tennessee Mines produced 16 per cent. of the total coal output in Tennessee in 1899. The Company's coke output was about 6½ per cent. of the total coke production of the United States in 1899. Its Alabama coke ovens made 60 per cent. of all the coke made in Alabama, and its Tennessee ovens 29 per cent. of the coke made in Tennessee.

PERSONALS.

Mr. John P. O'Neill has been appointed Superintendent of the Anaconda Company's Mines.

Professor John C. Smock, for the last ten years geologist of the State of New Jersey, has tendered his resignation.

Mr. Thos. H. Heald, for many years president of the Black Diamond Coal Co., operating mines at Coal Creek, Tenn., has gone east on a vacation. The affairs of the company having passed into new hands.

Mr. Geo. N. Nolan tendered his resignation as secretary of the Southwest Miners' Association, of Los Angeles, Cal., to take effect at once. His resignation has been accepted and Mr. James H. Fountain has been appointed to that office.

Messrs. M. R. Muckle, Jr. & Co., the Philadelphia representatives of Messrs. Westinghouse, Church, Kerr & Co., have removed to their new office, No. 512 Stephen Girard Building, No. 21 South 12th Street, Philadelphia, Pa.

The Nitro Powder Co., of Kingston, N. Y., has recently received the contract from Winston & Co. & Locher, of Clinton, Mass., for their entire supply of dynamite about 150,000 lbs., to be used on their big contract for the construction of the Wassachusetts Dam, at Clinton, Mass.

Mr. William Scallian has been elected President of the Anaconda Copper Company to succeed the late Marcus Daly. Mr. Scallian has had a long connection with these works, and his promotion in office means a continuation of policy heretofore pursued by the company.

Otto H. Tittman, assistant superintendent of the U. S. Coast and Geodetic Survey, has been promoted to the superintendency, vacant by the resignation of Dr. Henry S. Pritchett, to accept the presidency of the Massachusetts Institute of Technology. Mr. Tittman has been connected with the Survey since 1867.

At the annual meeting of the California Miners' Association held in San Francisco, November, 19, 1900, the following officers were elected for the ensuing year: President, E. C. Voorhies; First Vice-President, Fred Zeitler; Second Vice-President, Lew E. Aubrey; Secretary, E. H. Benjamin; Treasurer, Samuel J. Hendy.

Mr. H. D. Crippen of New York City has become sole licensee for the manufacture and sale of the Jackson Hand Power Rock Drill throughout the United States and also in foreign countries. He will put on the market drills manufactured in the eastern part of the United States, the shells of which will be constructed of 60,000 tensile strength steel and the interior mechanism of the best quality of tool steel.

Mr. R. Van A. Norris has been appointed Chief Engineer of the following Coal and Water Companies of the Pennsylvania Railroad Company, vice Mr. J. H. Bowden, deceased. Susquehanna Coal Company, Mineral Railroad & Mining Company, Summit Branch Coal Company, Lykens Valley Coal Company, Nanticoke Water Company, Lykens Water Company.

Edward McDowell and associates, Atlanta, Ga., have purchased a dredge-boat of 1,200 yds. per day capacity, and will dredge in the Chattahoochee river for gold. The same parties are about to install a plant on a 100-ft. vein of saprolite gold ore that will log-wash a grade of mill-stuff good for \$4 per ton on a total expense for mining and milling of about 50c.

Mr. H. W. Hoyt, Secretary and General Manager of Gates Iron Works, Chicago, Ill., was elected President of the National Founders' Association at its recent convention in New York. The National Founders' Association is the largest body of employers in the United States having the avowed object of promoting harmonious relations with its employees. The Association represents a capitalization of more than \$200,000,000.

James McCrear & Co., 15-17 S. Canal St., Chicago, manufacturers of steam specialties, have recently placed an agency for their Climax Steam Joint Clamp with Geo. I. Roberts & Bros., 471 and 473 Fourth Ave., New York, who will carry a complete stock and who are in a position to fill all orders promptly. They have also placed an agency for the Pacific Coast with Pierce, Bird & Co., 31 Main St., San Francisco, Cal., who will also carry a stock of the clamps.

At the eleventh annual meeting of the Engineering Association of the South, held at Nashville, Tenn., Nov. 8th, the ballot for officers resulted in the election of the following: President, Maj. Niles Meriwether, Memphis, Tenn.; 1st Vice President, Mr. W. H. Schuerman, Nashville, Tenn.; 2d Vice President, G. M. Ingram, Nashville, Tenn.; Secretary and Treasurer, H. M. Jones, Nashville, Tenn.; Resident Directors, Messrs. Jas. Geddes, E. C. Lewis, and R. T. Creighton; for Directors from membership at large: G. F. Blackie, Mt. Pleasant, Tenn., G. D. Fitzhugh, Birmingham, Ala., E. E. Betts, Chattanooga, Tenn., and C. S. Brown, Nashville, Tenn.

On Nov. 20th and 27th Mr. H. F. J. Porter of the headquarters staff of Bethlehem Steel Company at South Bethlehem, Pa., addressed the classes of the Brooklyn Institute of Arts & Sciences in the public lecture course, his subjects being, "The Development of the Forging Industry" and "Modern Methods of Making Steel Forgings," respectively. On Nov. 24th the lecture last mentioned was repeated before the German Technical Society of Philadelphia, and on Saturday evening, Dec. 8th, Mr. Porter exhibited before the Winter Conversazione of the Franklin Institute in that city turnings made by tool-steel treated by the "Taylor-White Process" which the Bethlehem Company is exploiting.

Mr. Asa M. Mattice has been appointed Chief Engineer of the Westinghouse Electric & Manufacturing Company; and entered upon his duties in December. Mr. Mattice was for ten years up to a year ago principal assistant to E. D. Levitt of Cambridgeport, Mass., and has been actively connected with the design of all the large machinery coming from Levitt's Office during that time. During the past year he has been remodeling the Cocheco Cotton Mills at Dover, N. H. Mr. Mattice is an engineer graduate of the Naval Academy of the class of '74, of which class Mr. B. H. Warren, Vice-President of the Westinghouse Electric & Manufacturing Company, is also a member. He was assistant to Admiral Melville at the beginning of the new navy; and had an important part in the design of the machinery of the "Maine," "San Francisco" and others of the important early ships. The Westinghouse Company is to be congratulated on the additional strength which he will give to its already strong engineering staff.

OBITUARY.

Mr. Thomas Benton Brooks, formerly State Geologist of the iron region of Michigan, died recently at his home in Newburg, N. Y.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Placer Mines of Washington.

Editor Mines and Minerals:

Please answer the following question through your paper: To what extent have the placer mines in Okanogan and Kittitas counties, Washington, been worked?

Box 1023, Tacoma, Wash.

FRED. JOHNSON.

Leaching Copper Ore.

Editor Mines and Minerals:

SIR:—Could you or some of your subscribers give me some information in regard to "leaching copper." I have a deposit of copper ore that will coat iron with copper in a very few minutes by putting water on the ore and then putting iron in it. And would like to know the process for working such ore, etc.

Hornbrook, Cal., Nov. 26th, 1900.

G. B. RYMAL.

Mis-Fire Shots With Electric Battery.

Editor Mines and Minerals:

SIR:—Will some reader of your valuable paper, give his reasons, why it is, that in using the electric battery you can connect a rounds of six shots, and only three of them go off. I have often seen this happen in my experience and it is a great source of danger in going back, and starting to work with a pick.

Larimer, Pa.

WM. CONDIE.

[This is partially answered in Prize Contest, Question No. 630, page 266.]

Capacity of Exhaust Pipe.

Editor Mines and Minerals:

SIR:—We have in our mining plant a 12-inch exhaust steam line. Exhausting into this are a 350 horsepower Ames Iron Works engine, a 230 horsepower engine of the same make, and a 22" x 24" Norwalk air compressor engine which is run at 210 revolutions per minute. I would like to know if two more engines of the same size respectively as those given above may exhaust into the same 12" pipe line. The exhaust pipe passes through a heater 80 feet from the nearest engine.

Thomas, W. Va.

Yours truly,
J. F. H.

Electricity vs. Compressed Air.

Editor Mines and Minerals:

SIR:—I should like to hear from some of your readers, who have had experience on the subject, as to the relative cost and advantages between electricity and compressed air for furnishing power to operate a 20-stamp mill and to run 4 machine drills in a mine. I would also like to have a rough estimate of the cost of installing either plant—either of which is to be operated by water power, of which we have plenty within one mile of the mine. We have at present in operation a 5-stamp mill and 2-drill compressors run by steam power, which we are shortly going to increase to a 20-stamp mill and 4-drill compressors, which I estimate will require 100 or more horsepower.

Mammoth Gold Mining Company,
Barron, Wash.

CHAS. H. BALLARD.

Sinking Shaft Through Swelling Strata.

Editor Mines and Minerals:

SIR:—In sinking a shaft or slope through wet soapstone the soapstone swells rapidly, forces the timber in until the cage or skip wedges and destroys the shaft. Can this be avoided? Where it is absolutely necessary to sink through such soapstone strata what is the best and cheapest way to avoid this difficulty? What precaution, if any, should be taken while constructing the shaft or slope so as to avoid future trouble from the swelling of the soapstone?

J. T. L., Norway, Mich.

What is commonly called "soapstone" in mining partakes of the nature of a strong fireclay; it is a joint clay that is hard as long as it is kept dry; but when water reaches such strata, the clay swells. There is no power that can prevent this swelling of the clay; it will burst any timber or break any frame that can be put in.

In sinking a shaft or a slope under such conditions, the strata

should be excavated for a certain depth so as to give a good clearance between the formation and the curbing all around the shaft. This space should be so arranged that a man can enter it and clear it from time to time as may be required. Drainage should be provided by a suitable ditch cut in the hard pan or floor underlying such strata, and this drain should be connected by a pipe leading to the sump at the foot of the shaft. A good circulation of air should be made to travel around the space thus excavated, so as to keep the clay as dry as possible.

J. T. B.

Title to Mining Claim.

Editor Mines and Minerals:

I have a mining claim on school land which this State is about to sell. I am not prepared with means or work done to apply for a patent or to contest with the State, unless I have to. If I buy the land from the State, will this give me a good title to my mining claim, or must I further protect myself against prospectors by getting my title from the United States?

The above inquiry was forwarded to the Commissioner of the Land Office, Washington, D. C., who replied as follows: "For obvious reasons, it is contrary to the practice of this office to express an authoritative or binding opinion except in an actual case in which the record has been regularly submitted."

"I am unable to cite a final decision in a case adjudicated by this Department or office in which the question you propound was passed upon and determined."

Very respectfully,

BINGER HERMANN, Commissioner.

To Find Temperature of Air in Shaft.

Editor Mines and Minerals:

SIR:—What is the rule to find the temperature of a shaft when the motive column, quantity, and horsepower are given.

Fierro, N. Mex.

T. H. O.

Multiply the horsepower by 33,000 and divide by the quantity of air in circulation; this will give the pressure per square foot causing the circulation. Divide this pressure by the motive column (M) in feet, and the quotient will be the weight of one cubic foot of air, at the same temperature as that of the motive column. Then, divide this weight of one cubic foot of motive column air into 1.3253, and multiply by the barometer (inches of mercury); the quotient obtained will be the absolute temperature of the motive column air. From this absolute temperature subtract 459 to obtain the common temperature.

Expressed as a formula this rule would read as follows:

Let t = average temperature of motive column air (degrees, F.),
 B = barometric pressure (inches of mercury),
 Q = quantity of air in circulation (cu. ft. per min.),
 M = height of motive column (ft.),
 H = horsepower.
 1.3253 = constant, weight of one cubic foot of air, at an absolute temperature of 1° F., and a pressure due to 1 inch of mercury.

Then,
$$t = \frac{1.3253 \times B Q M}{33,000 H} - 459.$$

J. T. B.

The Llano Mineral Fields.

AUSTIN, Texas, November 27.—Dr. W. B. Phillips, professor of field geology in the University of Texas, has just returned from a visit to the mineral regions around Llano. With reference to what is going on up there towards developing the mineral resources, he says:

"I have returned from a trip into Llano County and was able to visit all the localities where prospecting for gold is now going on. Six and a half miles northeast of Llano, Mr. T. F. Keith and associates have a shaft down thirty-eight feet with 150 feet of drifts turned off from the bottom. The gold occurs in the decomposed schists which overlie the granite of that vicinity. A mile and a half a little south of west Mr. G. C. Nunnerly is opening another prospect and has several men at work. It is reported that work is to be resumed at the old Schryver mine in the same neighborhood. This was put down to a depth of 585 feet and operations were suspended two or three months ago."

"These three localities are in what I will term the Lone Grove District, as Lone Grove is the nearest postoffice. They exhibit the same general features, as in each case the gold is carried by granitoid schists more or less decomposed and traversed by stringers of quartz. Some of the samples from the district have shown excellent values. Pending the assay of samples which I took myself I can only quote those that were submitted to me as representing the ore of the district. These show gold values varying from \$4 to \$52.31 per ton, with but little silver. Assays of picked samples run much higher. For instance, I was

given an assay which showed \$2,168 per ton in gold, and another ran even higher than this.

"Six miles south of Llano, in the Sharp Mountain district, some prospecting has been carried on, but work has been suspended there for some time. I was given to understand that some properties in this district would be soon prospected, as also some lead properties in Burnet County, assays of which have shown as high as 55 per cent. of lead. The Llano County gold belt certainly deserves attention and it is hoped to supplement the labors of the former surveys by assays of material sampled in person. A good deal has been said about the gold ores of that county, and I hope to give a lot of time to the subject.

"It is probable that the Llano County gold belt will develop some paying mines, provided the processes to be introduced are based on the special nature of the ores. It would be useless to attempt to treat a great deal of the material I saw in an ordinary stamp mill; it is too soft and friable to be stamped and should be handled in a Huntington mill or in the improved arrastra. I make this suggestion because some of those interested in the matter are considering the stamp mill. This is all right for hard ores, quartz, etc., but it is not suitable for all kinds of ore. Another point is that no machinery of any kind should be put in until the mines have been fairly well developed. Many gold mining plans have come to grief on this snag. See what the ore is and how much there is, then put in machinery to suit the special conditions."

Editor Mines and Minerals:

SIR:—The above clipping describe the Llano district very briefly, but so far as it goes it is precisely my decision after three trips over—not only Llano, but five adjoining counties, excepting that Mr. Phillips is letting them down too easy. I found the country literally honey combed with old, abandoned holes. Many thousands of dollars have been put into that district. Every little town has mine machinery stored away in it from some abandoned hole. Has any one the talent to resurrect it?

Every other river in Texas runs through limestone and sandstone formations, and drains a gently sloping plateau, with sluggish winding current, and cutting through a deep alluvial bottom, sometimes miles wide, of an older stream, and usually following the course of the older stream; hence the terrible destruction of life and property along these rivers when they refill their old beds. While this is true of every other river, the Llano river is a startling exception. The U. S. Geo. Survey in '99, where I was prospecting in Gillespie county came up out of spurs of Llano river 700 feet to top of limestone formation.

From the top down it ranges thus: a soil quick with lime, and filled with grayish blue flints, then great horizontal beds of limestone, the top layers often full of cavities lined with silica crystals, then hundreds of feet of old red sandstone, cemented into a blackish mass by iron and silica solutions, then schists in irregular formation, and then granite, in all the varying grades. The Schryver mine, 600 ft., is deepest hole in this granite. Their assayer told me at 450 ft. it was same low grade, almost barren rock. Have not been there since. This Llano valley is some 30 or 40 miles wide, with all the upper limestone and sandstone carried out of it, the river being a clear stream running through its granite walls, 700 ft. below the surrounding plateau.

C. B. SHARER, Esq.

Flatonia, Fayette Co., Texas, Nov. 29, 1900.

Haulage Problem.

Editor Mines and Minerals:

SIR:—We have noticed that the question of H. L. D. W. in the Correspondence Columns of your August issue has as yet received no reply. This being an important question, and one in which all practical men should be deeply interested, we had hoped it would call forth a reply. The conditions stated in the question at first sight seem to be entirely practical, but upon a little investigation it is seen that the rope will be too heavily loaded in this case, where required to pass over deflecting sheaves, except where the angle of deflection is small. The question reads as follows: If the modulus of elasticity is 29,000,000; the elastic limit 57,000 pounds; the working load one-fifth of the ultimate strength of the rope, which is 1 inch in diameter and composed of six strands of seven wires each, or a total of 42 wires of material that has a breaking strain of 201,600 pounds per square inch, (1) What is the minimum diameter of drum on which this rope may be used? (2) What is the bending strain? (3) What is the radius of a curve, on which 8-inch sheaves set 3 feet apart, will give the same bend in the rope at each 8-inch sheave, as if the rope were going round a sheave of minimum diameter for this rope? (4) What in case (3) will be the bending stress?

(1) Since the material of the rope has a breaking strain of 201,600 pounds per square inch, and the working load is $\frac{1}{5}$ of the ultimate strength of the rope, we may assume for the working load, say 40,000 pounds per square inch. Now, since the elastic

limit is 57,000 pounds, we have $57,000 - 40,000 = 17,000$ pounds per square inch of permissible load due to bending, before reaching the limit of elasticity of the material. Calling f the unit stress due to bending, in the outer fibers of the rope, E the modulus of elasticity for the material, d the diameter of the outer wires, D the diameter of the radius of curvature assumed by the outer wires, we have as the expression for the unit stress due to bending, in the outer wires of the rope, $f = E \frac{d}{D}$; and from this expression we obtain

$D = E \frac{d}{f}$. Then, since the ratio of the diameter of the wire to

the diameter of the rope for 6-strand, 7-wire ropes is $\frac{1}{4}$ (See MINES AND MINERALS, page 90, September, 1900), and the diameter of the rope is one inch, the diameter of the outer wires will be $\frac{1}{4}$ "', and calling E 29,000,000, and f 17,000, we have,

$$D = E \frac{d}{f} = \frac{29,000,000}{17,000 \times 9} = 189.5, \text{ say, } 190 \text{ in. min. diam.}$$

This is the diameter of the radius of curvature for the outer wires of the rope when the stress due to bending is 17,000 pounds per square inch in the outer wires; and since the diameter of the rope is one inch, we have for the minimum diameter of drum $190'' - 2'' = 188''$ or $15' 8''$. As this rope in its passage through the mine will be required to traverse single sheaves of less diameter than this, we see at once that the rope will be strained beyond its elastic limit, under the conditions named in the question.

(2) The bending stress or the stress due to bending exerted in the outer fibers of the rope is, in this case, 17,000 pounds per square inch, as previously observed.

(3) In this question our correspondent virtually asks, What is the radius of a curve on which 8'' sheaves set 3' apart will produce a bending stress of 17,000 pounds per square inch, in the outer fibers of the rope, at each 8'' sheave? We may solve this question in either of two ways. (1) We may determine the radius of curvature that will produce a bending stress equivalent to a load of one pound upon the rope; and by consulting the table giving the rigidity of ropes, find what angle of deflection in the rope will cause it to assume, under this load, a curvature having this radius. The angle of deflection thus found from the table will be the angle of deflection at each 8'' sheave. (2) We may calculate the total load upon the rope which corresponds to a load of 17,000 pounds per square inch. Thus, in this rope, $17,000 \times 42 \times \left(\frac{1}{9}\right) = 6,923 \text{ lb.}$ We may then refer back to the radius corresponding to the minimum diameter as found above ($\frac{190}{2} = 95''$), and multiply this minimum radius, for this

rope, by 6,923 to obtain the minimum radius for a load of one pound upon the rope, since the radius of curvature in a rope is inversely proportional to the load; thus, $95 \times 6,923 = 657,685 \text{ in.}$ We then consult the table referred to above, expressing the rigidity of ropes under a load of one pound, to find the angle of deflection of the rope at which it will assume, owing to its rigidity, a curvature having this minimum radius. We prefer the first method for determining the angle of deflection of the rope.

In order to determine the radius that will produce a bending stress equivalent to a load of one pound upon the rope, we use the formula $D = E \frac{d}{f}$, and since f is the unit stress due to bending,

we substitute for its value, in this case, $\frac{1}{n(.7854 d^2)}$, and for D its value $2R$, giving the formula (MINES AND MINERALS, September, 1900, page 92, formula 1) $R = .7854 E \frac{n d^2}{2}$. In this formula it is assumed the diameter is uniform for all the wires of the rope; and n being the number of wires, the sectional area of metal in the rope, is $n(.7854 d^2)$. We use this formula because the unit stress due to bending, or the resistance per unit of area, to bending, in the outer fibers of the rope, is always equal to the unit load upon the rope producing the bending. Substituting in this formula the given values, we have,

$$R = \frac{.7854 \times 29,000,000 \times 42}{2 \times 9} = 656,000 \text{ in.}$$

Referring to the table previously mentioned, we find that a new, one inch, 7-wire rope will assume this radius (656,000 inches) under a load of one pound, when the angle of deflection is between 5° and 10° . We therefore are safe in assuming 5° for the angle of deflection at each 8-inch sheave; and from this we readily calculate the radius of curvature of the curve through the centers of the 8-inch sheaves, that will produce a deflection of 5° , in the rope, at each sheave, the distance between the centers of the sheaves being 3 feet; thus,

$$R = \frac{3}{2 \times \sin(\frac{1}{2}^\circ)} = \frac{3}{2 \times .04362} = 34.4, \text{ say } 35 \text{ ft.}$$

This is a very practical question and one which should be thoroughly understood by all interested in mine haulage, as it furnishes a simple and effective method of determining the radius of curvature which should be used when laying out a curve in any haulage road.

(4) The bending stress induced in the outer fibers of the rope under the above conditions will be as estimated above 17,000 pounds per square inch. The total load upon the rope will be $40,000 + 17,000 = 57,000$ pounds per square inch, which is within the elastic limit of the rope. J. T. BEARD.

Meeting of the American Society of Mechanical Engineers.

The annual meeting of the American Society of Mechanical Engineers was held in New York city, Dec. 4th to 7th, inclusive. The first session was in the Society's parlors, 12 W. 31st St., Tuesday evening, Dec. 4th. The first meeting was practically all taken up by the annual address of the retiring president, Mr. Charles H. Morgan. At the second meeting, Wednesday morning, Dec. 5th, also held in the Society's rooms, all business, such as the reports of the council, tellers, finance, and library committees, and other special business, was attended to. The new president, Mr. C. H. Wellman, was escorted to the platform, welcomed by Mr. Morgan, and then made a short speech thanking the Society for the honor they had conferred upon him. The balance of the session was taken up by the following papers: "Comparison of Rules for Calculating the Strength of Steam Boilers," by H. DeB. Parsons; "Record of the Early Period of High Speed Engineering," by Chas. T. Porter; "Steam Engine of Maximum Simplicity and of Highest Thermal Efficiency," by Robt. H. Thurston. All of these papers were quite freely discussed by the members. After the session a luncheon was served in the lower room of the building and an informal social time enjoyed for an hour or so. Wednesday afternoon was left open in order to enable the members to attend to any business that they might have in the city. At the session Wednesday evening, Dec. 5th, the following papers were presented: "Note on Centrifugal Fans for Cupolas and Forges," by Wm. Sangster; "Power Plant of the Massachusetts General Hospital," by F. W. Dean; "The Construction of Contracts," by R. P. Bolton; "An American Central Valve Engine," by E. T. Adams. On Thursday, Dec. 6th, the members of the Society were the guests of Columbia University. The morning session was held at 10:30 in the lecture room of Havemeyer Hall of the University buildings. Just before adjournment President Low made a short address and subsequently received the Society in the Trustees' Room in the Library Building. Lunch was then served in the Engineering Building, after which the members visited the various laboratories of the University. In the Mechanical Laboratory the locomotive "Columbia," was running as was also the Allis Experimental Engine and much other interesting machinery. At the morning session the following papers were read: "Mechanical Integrator Used in Connection with a Spring Dynamometer," by Max H. Wickhorst; "Apparatus for Dynamically Testing Steam Engine Indicators," by Carleton A. Read; "A New Recording Air Pyrometer," by W. H. Bristol. This paper was illustrated by two of the pyrometers which were coupled up and exhibited. "Comparative Value of Different Arrangements of Suction Air Chambers on Pumps," by F. Meriam Wheeler. This paper was illustrated by charts. Later in the day the engineers were shown the pumps in the laboratory running under different conditions illustrating the points brought out in the paper. Prof. W. F. M. Goss's paper which was to have been read at this session was postponed to a later session. Thursday evening there was a reception for the members and their guests at Sherry's, the President and the President-elect receiving the members. The closing session of the convention was held at 10:30, Dec. 7th, in the Society's Hall. Prof. W. F. M. Goss's paper on "Tests of the Boilers of Purdue Locomotive," which had been postponed from the previous session, was read at this session as were also papers upon "Tests of Centrifugal Pumps," by W. B. Gregory; "Hardness, or the Workability of Metals," by Wm. J. Keep; "Heat Efficiency of the Gas Engine as Modified by Point of Ignition," by C. V. Kerr, and "Power and Light from the Machine Shop and Foundry," by Forrest R. Jones. At the close of this meeting the Society adjourned and a Council Meeting was held at 3 o'clock in the afternoon.

The officers for the year 1900-1901 are as follows:

President, Samuel T. Wellman, Cleveland, O.

Vice-Presidents, David Townsend, Philadelphia; Stevenson Taylor, Hoboken, N. J.; Jesse M. Smith, New York City; A. M. Watt, New York City; Jas. M. Dodge, Philadelphia; Ambrose Swasey, Cleveland.

Managers, E. C. Felton, Harrisburg, Pa.; A. M. Goodale, Waltham, Mass.; R. H. Soule, New York City; F. H. Boyer, Somerville, Mass.; Jno. A. Brashear, Alleghany, Pa.; Alfred H.

Raynal, Washington, D. C.; W. F. M. Goss, LaFayette, Ind.; DeCourcy May, Scranton, Pa.; D. S. Jacobus, Hoboken, N. J. Treasurer, Wm. H. Wiley, New York City.

Secretary, F. R. Hutton, New York City.

(Those marked with ‡ were elected at the present meeting, the others being elected at previous meetings, the vice-president being elected for a term of 2 years and the managers for a term of 3 years.) The total registration at the meeting was 750, making this by far the best attended meeting which the Society has ever held.

Several companies exhibited automobiles and runabouts during the meeting and allowed the members the use of them. Among these were: The Locomobile Co., of America, whose address is 76th St. and Broadway, New York City, and the De Dion-Bouton "Motorette" Co., Church, Lane and 37th Sts., Brooklyn, N. Y., these two companies having placed quite a number of vehicles at the disposal of the members during the session on Wednesday and Thursday. On Friday the Adams Express Co. sent, through the courtesy of Mr. Arthur Herschmann, their mechanical engineer, a large 3-ton freight truck and exhibited it to the members.

On the whole, the meeting was generally considered the best that the Society had held up to the present date.

The Otis Tubular Feed Water Heater, Oil Separator and Purifier.

There is no piece of machinery that will save its cost more quickly than a good feed water heater.

The Otis feed water heater here illustrated is manufactured by The Stewart Heater Co. of Buffalo, N. Y., and is guaranteed by the makers to heat and purify the feed water for steam boilers with exhaust or waste steam to the highest temperature possible, without causing any back pressure on the engines or steam pumps from which the exhaust steam is taken. This heater is also guaranteed not to become foul with scale, as there is a cool settling chamber at the bottom where the sediment will settle below and away from the tubes, and remain soft and can be easily and quickly removed. It is guaranteed to continue to heat as hot after years of use, as when new, as there is no hot flat tube sheet in the bottom where the sediment can settle and bake on as scale.

The makers also claim the separator in the Otis Heater will extract and remove more oil from the exhaust steam than any eliminator in the market, as it is a well known fact that oil that is carried over with the exhaust steam when it comes in contact with cool surfaces, when such surfaces are provided, will chill very quickly, and then must drop to the bottom of the separator. As the inside of the separator is corrugated and surrounded at all times by the cool feed water, when the oil that is in the exhaust steam first enters the heater it must pass out through the drip pipe that is provided. As the exhaust pipes are connected at the top in this heater, the exhaust steam must pass down through one section of the seamless brass tubes, therefore the oil will become chilled while passing through the separator and pass off through the drip pipe which is provided at its bottom, as shown. The exhaust steam after passing through this separator then passes up through the other section of tubes, free from oil and can be used for other heating purposes. The water of condensation can be returned to the boilers without the extra expense of an additional oil separator or eliminator. Steam users about mines find that the impurities in the water which cause them so much trouble are very largely eliminated, thus the feedwater heater not only adds to the efficiency of the plant, but reduces the labor of cleaning and repairing.

All Otis feed water heaters are thoroughly tested to 175 lb. hydrostatic pressure, and guaranteed as perfect as time and money can make them. They are shipped on their merits, and guaranteed to give perfect satisfaction in every respect at the risk of the manufacturer. Steam users should be interested in an article that is as thoroughly guaranteed as the Otis Heater, and by addressing The Stewart Heater Co. of Buffalo, N. Y. a circular with table of dimensions will be forwarded free.



PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for January.

QUES. 644.—*Gravity Plane*.—(a) How many cars should be run in a trip upon an incline 5,000 feet long and having an inclination of $4^{\circ} 30'$, when the cars weigh 1,800 pounds each and have a capacity of 3,200 pounds of coal? (b) At what velocity should the cars be run on this incline to lower 96 tons of coal per hour, allowing one minute between trips for change of rope and loss of time in starting and stopping? Calculate the angle of inclination and the length of the steep pitch at the head of the incline to give this required velocity. Assume the coefficient of rolling friction as .025, and use a $\frac{3}{4}$ -inch rope weighing .88 pound per lineal foot and having a breaking strain of 25 tons.

QUES. 645.—*Mining Two Contiguous Seams of Coal*.—Describe how you would proceed to mine two contiguous seams of bituminous coal, separated by 30 inches of clay parting. The lower seam is 3 feet 6 inches thick, and the upper seam 2 feet in thickness. The quality of the upper seam is particularly good while the lower seam contains considerable sulphur (pyrites). The floor of the lower seam is a fire clay 18 inches in thickness, which readily heaves. The stratum overlying the upper seam is a hard slate 25 feet thick. The seam is flat, lying at a depth of 200 feet below the surface.

QUES. 646.—*Gas Encountered Beyond a Fault*.—In driving a heading in a level seam of coal, a fault was encountered which proved to be an upthrow. The heading was driven through the fault and then an upraise started upon the other side of the fault to find the continuance of the seam. The amount of displacement was 5 feet, and the upraise had been driven but 3 feet in the roof strata when gas was encountered. Previous to this, it had not been known that any gas existed in the seam. The ventilation of the heading was ample, a large volume of air being in circulation. A safety lamp elevated into the upraise was immediately extinguished. State, what in your opinion, this gas was, and explain the conditions which would give rise to such a phenomenon.

QUES. 647.—*Size, Inclination, Speed, etc. of Conveyor*.—Give size, inclination and speed of a conveyor that will lift 60 tons of anthracite coal per hour to a height of 50 feet. Describe briefly the construction of the same and give the horsepower required for its operation.

QUES. 648.—Describe the best form of fan casing and state how you would proceed to lay out and construct the same.

QUES. 649.—*Boiler Connections, Allowance for Expansion*.—In setting a nest of boilers and making the necessary connections with the main steam pipe, describe how you would provide for the expansion and contraction of the steam line.

QUES. 650.—*Oak vs. Iron Tracking in Mines*.—Explain the use of oak and iron tracking, stating the conditions under which each may be used with advantage.

QUES. 651.—*Gauge of Mine Tracks*.—What do you consider the best gauge for mine tracks; state the relative advantages and disadvantages of wider or narrower gauges.

Answers to Questions Which Appeared in the November and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 610.—*Ventilation, Effect of Splitting the Air Current Upon the Speed of a Fan*.—The power remaining the same, what effect will the splitting of the air current into two equal splits have upon the speed of the ventilator? State the reasons for your answer.

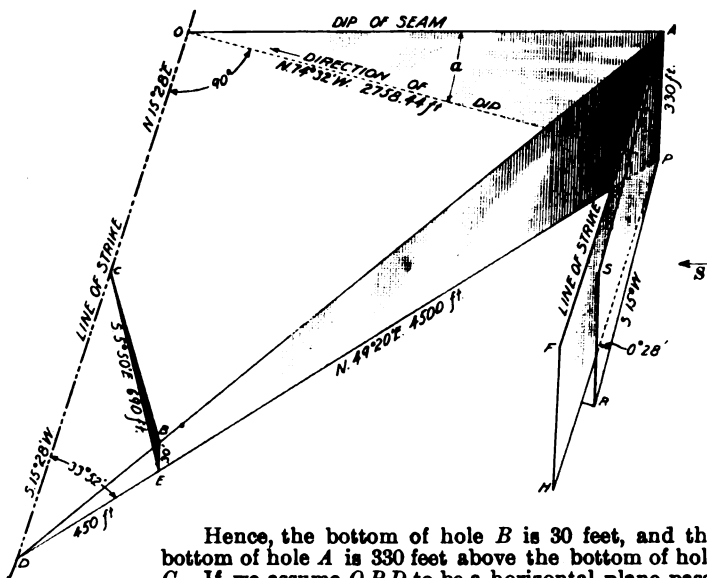
ANS.—The result of splitting the air, under the condition named, will be a greatly increased volume going through the fan and the mine. Now, [although the mine resistance is the same as before splitting, the total resistance has been increased, owing to the increased resistance in the fan.] a greater volume of air is delivered and therefore a greater weight of air handled in a given time. But the power remaining the same, a greater load can only be handled at the expense of speed, and the fan will therefore necessarily run slower.

JOHN VERNER, Oskaloosa, Iowa.

Second Prize.—THOS. CHARLTON, West Leisenring, Penna.

QUES. 625.—*To Determine the Dip of a Seam by Means of Three Bore Holes*.—In order to determine the amount and the direction of the dip of a certain coal seam, three holes were sunk to the seam as follows: Hole A is $N 49^{\circ} 20' E$, 1,500 yards from hole B; and hole B is $S 5^{\circ} 50' E$, 230 yards from hole C. The surface elevations above datum, and the depth of the holes are respectively as follows: A, elevation 980 ft., depth 300 ft., B, elevation 650 ft., depth 270 ft., C, elevation 1,090 ft., depth 740 ft. Determine the depth of a shaft located at a point 400 ft. $S 15^{\circ} W$ of hole A, where the surface elevation is 710 ft.; also determine the course or bearing of a slant road in this seam having a grade of 1 in 10, dipping in a southerly direction.

ANS.—
Elevation of hole A, in seam, is $980 - 300 = 680$ ft. above datum;
Elevation of hole B, in seam, is $650 - 270 = 380$ ft. above datum;
Elevation of hole C, in seam, is $1,090 - 740 = 350$ ft. above datum.



Hence, the bottom of hole B is 30 feet, and the bottom of hole A is 330 feet above the bottom of hole C. If we assume OPD to be a horizontal plane passing through the bottom of the lowest hole C, and OAD the inclined plane of the seam, the points A, B and C, indicating the bottoms of the three respective holes in the seam; and drawing the vertical lines BE and AP ; BE will be 30 feet, and AB 330 feet in length. We first find the distance ED from the proportion $AP : BE :: PD : ED$; or, substituting values, and calling ED , x , we have $330 : 30 :: (4,500 + x) : x$, and

$$(330 - 30) : 30 :: 4,500 : x,$$

$$x = \frac{30 \times 4,500}{300} = 450.$$

or
Direction of Strike.—The line of strike is the line DC , being the intersection of the plane of the seam with the horizontal plane. (See answer P. C. Question 607, MINES AND MINERALS, Page 122, October, 1900.) The bearing of the lines ED and EC are respectively $S 49^{\circ} 20' W$, and $N 5^{\circ} 50' W$, and their respective lengths are 450 and 690 feet. The angle included between these lines is therefore $124^{\circ} 50'$. To determine the direction or bearing of the

line DC , we solve the horizontal triangle DCE in which two sides and their included angle are known. Indicating the respective angles of the triangle by the large letters D, C, E , and the opposite sides by the small letter d, c, e respectively, we have $\tan \frac{1}{2}(D+C) : \tan \frac{1}{2}(D-C) :: (d+c) : (d-c)$, and substituting values we have finally, since $D+C = 180^\circ - E$, $\tan \frac{1}{2}(D-C) = \frac{690-450}{690+450} \times \tan 90^\circ - (62^\circ 25') = \frac{240}{1140} \times .52242 = .10998$; and $\frac{1}{2}(D-C) = 6^\circ 17'$. But $\frac{1}{2}(D+C) = \frac{1}{2}(180^\circ - 124^\circ 50') = 27^\circ 35'$. Then, to obtain the greater angle D , lying opposite the greater side, we add the half sum of C and D to the half difference; or $D = 27^\circ 35' + 6^\circ 17' = 33^\circ 52'$, and the bearing of the strike DC is therefore, $49^\circ 20' - 33^\circ 52' = 15^\circ 28'$, or $N 15^\circ 28' E$, or $S 15^\circ 28' W$.

Direction and Amount of Dip.—The direction of the dip is indicated by a line PO drawn at right angles to the line of strike and its bearing is therefore: $N 74^\circ 32' W$.

The amount of dip or angle of dip AOP , which we will call a for future use, is found by the formula: $\frac{AP}{OP} = \tan a$. From the horizontal right angled triangle POD we find

$$OP = (450 + 4,500) \sin 33^\circ 52', \text{ whence } OP = 2,758.44 \text{ ft.}$$

By substituting values we have

$$\frac{330}{2,758.44} = \tan a \quad 0.11963, \text{ whence } a = \text{say } 6^\circ 49'.$$

Depth of Shaft.—Let S represent the bottom of the shaft in the plane of the seam and PR the horizontal projection of the line $AS = 400$ feet; and draw AF or the line of strike through A , its horizontal projection being PH ; then a line drawn through R perpendicular to PH is a line of true dip projected on the horizontal plane, and equals $400 \times \sin 0^\circ 28' = 400 \times .00814 = 3.256$ ft.; and $3.256 \times \tan 6^\circ 49' \text{ (dip angle)} = 3.256 \times .11963 = .39$ ft., which is the vertical height of the bottom of the shaft above the bottom of hole A ; hence the elevation of the bottom of the shaft is $680 + .39 = 680.39$ feet above datum.

Surface Elev. at collar of shaft = 710.00

Elev. at bottom of shaft..... 680.39

Depth of shaft..... = 29.61 feet.

Course of Slant Road Having a Grade of 1 in 10 or 10 Per Cent.—Referring to the formula given in answer to question 590, MINES AND MINERALS, page 26, August, 1900: percentage of grade of slant road = $100 \cos \beta \times \tan a$, in which β = angle which the direction of slant road makes with the direction of dip.

$\tan a = 0.11963$ (see above).

Substituting values we have for a 10 per cent. grade,

$$10 = 100 \cos \beta \times 0.11963, \text{ whence}$$

$$\cos \beta = \frac{10}{100 \times 0.11963} = 0.83591 \text{ or } \beta = 33^\circ 17'.$$

The direction of the dip being $N 74^\circ 32' W$, we have for the required bearing of the slant road:

$$180^\circ - (74^\circ 32' + 33^\circ 17') \text{; or, } S 72^\circ 11' W.$$

Prizes were awarded in the December issue as follows:

THEODORE SIMONS, Roseland, B. C.

Second Prize.—FREMONT CRANE, Spokane, Wash.

QUES. 628.—*Efficiency of a Pump.*—Determine the efficiency of a pump that is discharging 1,200 gallons of water per minute, under a vertical head of 250 feet, at an expenditure of 125 horsepower. What should be the diameters of the discharge and suction pipes respectively of this pump?

Ans.—The total head against which the pump operates is the vertical height (h) of the point of discharge above the sump (gravity head), plus the head due to the friction of the water in the pipes (friction head, h_1). This friction head (see page 475, MINES AND MINERALS, May, 1900) is found by the formula

$$h_1 = \frac{f l G^2}{8 d^5}, \text{ in which } f = \text{coefficient of friction of the water in the pipes; } l = \text{length of pipe (ft.); } d = \text{diameter of pipe (in.); } G = \text{gallons discharged per minute. } 8 \text{ is a constant. Assuming the value of } f \text{ to be .01, and substituting the given values, we have, since the diameter of the delivery pipe is 9 inches (see below), } h_1 = \frac{.01 \times 250 \times 1,200^2}{8 \times 9^5} = 7.6 \text{ ft. In this case, } h = 250$$

feet, therefore, the total head [including the suction and friction heads] is $250 + 7.6 = 257.6$ ft. The theoretical power required for this work is $\frac{1,200 \times 8.33 \times 257.6}{33,000} = 78$ horsepower. But, as

the pump is using 125 horsepower, its efficiency is $\frac{78}{125} \times 100 = 62.4$ per cent. Assuming that the velocity of the water in the discharge pipe is 400 feet per minute, and in the suction pipe, 200 feet per minute, the required area of the discharge pipe is $\frac{1,200 \times 231}{400 \times 12} = 57.75$ sq. in., and its diameter $\sqrt{\frac{57.75}{.7854}} = 8.57$, say

9 in. The required area of the suction pipe is $\frac{1,200 \times 231}{200 \times 12}$

$$= 115.5 \text{ sq. in., and its diameter } \sqrt{\frac{115.5}{.7854}} = 12.1, \text{ say } 12 \text{ in.}$$

E. C. DAVIES, Duryea, Penna.

Second Prize.—THEODORE SIMONS, Spokane, Wash.

QUES. 629.—*Relative Diameters of Steam and Water Cylinders in Pumps.*—Determine the relative diameters of the steam and water cylinders of a direct acting pump when the vertical lift is 300 feet, the steam pressure at the bottom being 75 pounds per square inch.

Ans.—Let

- D = diameter of steam cylinder (in.),
- d = diameter of water cylinder (in.),
- H = horsepower actually used,
- p = steam cylinder pressure (lb. per sq. in.),
- S = piston speed (ft. per min.),
- g = amount of discharge (gal. per min.),
- h = vertical lift (ft.).

then

$$D = 205 \sqrt{\frac{H}{pS}} \quad 1.$$

$$d = 5.535 \sqrt{\frac{g}{s}} \quad 2.$$

$$H = 0.00038 g h. \quad 3.$$

Combining equations 1 and 3, and substituting given values, we have:

$$D = 205 \sqrt{\frac{0.00038 g \times 300}{75 S}} = 7.992 \sqrt{\frac{g}{S}}.$$

In order to find the relation between the diameters of the steam and water cylinders we divide the value of D by the value of d , as given in equation 2; thus,

$$\frac{D}{d} = \frac{7.992 \sqrt{\frac{g}{s}}}{5.535 \sqrt{\frac{g}{s}}} = \frac{7.992}{5.535} = 1.44.$$

In other words, in a direct acting pump, when the vertical lift is 300 feet, for a steam cylinder pressure of 75 pounds per square inch, the diameter of the steam cylinder should be made 1.44 times that of the water cylinder.

THEODORE SIMONS, Spokane, Wash.

Second Prize.—THOMAS ENGLISH, Streator, Ills.

QUES. 630.—*Cause of a Shot's Hanging Fire.*—Explain the conditions which may cause a shot to hang fire, in both fuse and electric blasting. In electric blasting is it possible for a shot to explode after the wires have been disconnected and the battery taken away?

In fuse firing a shot may hang fire owing to defective tamping, causing the fuse to burn slowly [or smoulder for a long period of time. A sharp piece of coal or stone may be forced by the tamping bar, against the fuse or driven into it so as to almost sever its connection with the charge. In this condition it is possible for the cotton of the fuse to smoulder for hours before eating its way past the obstruction. Or if the "missed" shot is picked out, the removal of the obstruction may cause an instant explosion.] Often, shot's hanging fire may be attributed to damp powder requiring that sufficient heat be generated to start ignition and cause the explosion. In electric blasting a shot may "hang fire" owing to too low a power of the detonator, or [possibly here also] to damp powder; the powder igniting only partially at first and requiring time for [the generation of sufficient heat to cause an] explosion. This may occur after the battery has been disconnected. A missed shot may explode from the detonation of a subsequent shot. M. B. SPAULDING, New York City.

Second Prize.—WILLIAM COWDIE, Larimer, Penna.

QUES. 631.—*Pumping With Compressed Air.*—A direct acting mine pump located at a distance of 500 yards inbye from the bottom of a shaft 300 yards deep, is operated by compressed air. The air is conducted from the surface down the shaft and to the pump, through a pipe 3 inches in diameter. The diameter of the air cylinder of the pump is 10 inches and the piston speed 100 feet per minute. The pump discharges at the top of the shaft, under a head of 1,000 feet. Assuming that the temperature of the compressed air at the surface is $80^\circ F$, its temperature at the pump $60^\circ F$, and the gauge pressure at the surface 90 pounds, (a) determine the gauge pressure at the pump when the pump is not running. (b) Determine the gauge pressure at the pump when the latter is in operation. (c) Determine the diameter of the plunger of this pump and its discharge in gallons per minute.

Ans.—(a) The gauge pressure at the pump when the pump is not running, is equal to the gauge pressure at the surface, plus the pressure due to the weight of the compressed air-column [less the increase of atmospheric pressure at the pump, 1,000 feet below the surface]. If the atmospheric pressure is, say 15 pounds

per square inch, at the surface, and the weight of a cubic foot of atmospheric air (temp. 60° F.) is .0776 pound, then the pressure gauge at the pump will register $.0776 \times \frac{90}{15} \times \frac{1,000}{144} + 90 = 93.19$ lb. per sq. in. [assuming that when the pump is idle the temperature of the air in the pipe falls to 60° F. The increase of atmospheric pressure for a depth of 1,000 feet below the surface is (temp. 60° F.) $.0776 \times \frac{1,000}{144} = .53$ lb. per sq. in. The gauge pressure at the pump when the latter is idle will, therefore, be $93.19 - .53 = 92.66$ lb.]

(b) [Since the velocities of the air in the pipe and the piston of the pump are inversely as the respective areas of the pipe and air cylinder of the pump, or the squares of their diameters, and directly as the absolute temperatures of the air in the pipe and pump; and ignoring the slight difference in velocity due to the small change in absolute pressure upon the air] we have for the average velocity of the air in the pipe when the pump is working, $\frac{.00}{60} \times \left(\frac{10}{3}\right)^2 \times \frac{459 + 70}{459 + 60} = 18.88$ ft. per sec. The loss of pressure for this velocity will be about 1.69 pounds for every 1,000 feet of length of pipe (see *The Coal and Metal Miners' Pocketbook*, 5th Edition, page 246) or a total loss of $1.69 \times \frac{(300 + 500) \times 3}{1,000} = 4.056$ lb. per sq. in. The pressure gauge will then show $92.66 - 4.056 = 88.6$ lb., when the pump is running.

(c) Assuming that $\frac{1}{3}$ of this pressure is lost in friction, etc. [$\frac{1}{3}$ becomes effective upon the water end of the pump, and calling the diameter of the plunger d (inches), we have, $(.7854 d^2) = \frac{1}{3} \times 88.6$ ($.7854 \times 10^2$), or, $d = 10 \sqrt{\frac{\frac{1}{3} \times 88.6}{.7854 \times 10^2}} = 3.7$, say $3\frac{1}{2}$ in. The number of gallons of water discharged by this pump each minute, allowing $\frac{1}{5}$ (20%) for slippage, will be $\frac{.7854 \times (3\frac{1}{2})^2 \times 100 \times 12}{231} \times \frac{4}{5} = 45.9$ gal. per min.]

ADOLPHE COOK, Cokeville, Penna.

Second Prize.—D. P. BROWN, Coalbrook, Penna.

QUES. 632.—*Safety Lamps With Copper Gauze*.—State the advantages and disadvantages arising from the use of copper gauze in safety lamps.

ANS.—The advantages obtained in the use of copper gauze are as follows: It is not as liable to rust and consequently retains its usefulness and lasts a great deal longer than iron wire gauze. When cleaned a copper gauze gives a brighter light than an iron gauze, and consequently is to be preferred when examining working places with a safety lamp.

The disadvantage of copper wire gauze is its great conductivity which allows the other parts of the lamp to heat more rapidly; [and also on account of the low specific heat, of copper, such a gauze heats readily and passes flame more quickly than an iron gauze].

PETER WELSH, Trauger, Penna.

Second Prize.—HUGH CAIRNS, Elco, Penna.

QUES. 633.—*Driving Roadways*.—State the manner in which you would drive a main roadway in a seam of coal 4 feet thick, the height of the roadway to be 5 feet in the clear above the rail. The floor of the seam is an underlay that heaves readily. Above the coal is a draw-slate varying from 18 inches to 2 feet in thickness overlaid with a hard slate.

ANS.—This seam affords excellent conditions for the long-wall advancing method of working, so far as concerns the height of coal, character of roof and bottom, as given in the question. In this system, I would keep all main roads 10 feet wide at the bottom, and take down the roof or draw slate for a width of 8 feet, at the top. This would furnish good material for building the road packs at the sides of the roads. In the gob the falling slate would furnish building material sufficient for all requirements.

If another system of working were adopted, however, and the roads were being made through the solid coal, I would drive these, say 15 feet wide, leaving a margin of 7 feet for pack wall, on one side of the 8-foot roadway. The roof slate could then be taken down over the roadway and packed on the side of the road next the entry pillar. [This would provide $7 \times 4 = 28$ square feet of space to stow $8 \times 2 = 16$ square feet of solid slate. When broken the slate will require about 75 per cent. more space than it occupied when solid.] As the bottom is soft I would have this side building packed as tightly as possible, and would carry a good ditch along the side of the building. The soft bottom would be kept, thus, free from water. [The clay bottom should not be disturbed near to either rib, as this will be liable to result in continual trouble.]

D. P. BROWN, Coalbrook, Penna.

Second Prize.—CHAS. KENYON, Ottumwa, Iowa.

QUES. 634.—*Method of Working an Inclined Seam of Coal*. Describe the manner in which you would open a breast in a seam of coal pitching 10°. The strike of the seam is N 60° W or

S 60° E, the direction of dip being S 30° W. The gangways or levels are driven so as to provide drainage toward the shaft. The face cleats of the coal are free and the coal is best worked "long-horn." Give the width of room and room pillars, and the direction in which the rooms should be driven. The general thickness of cover is 250 feet, the coal is a good quality. The roof slate is 18 feet in thickness, and strong, the floor is a hard fireclay.

[This is a good practical question relating to the method of working an inclined seam of coal which requires that the breasts be driven at a sufficient angle with the cleats of the coal to afford the necessary support while mining. The question is still open.—EDITOR.]

QUES. 635.—*Bending Stress in a Wire Rope Passing Over a Sheave*. Calculate the bending stress (lbs. per sq. in.) in the outer fibers of a $1\frac{1}{2}$ " steel wire rope having 6 strands of 7 wires each, when passing over a sheave 9 feet in diameter. If the actual net load upon this rope is 5 tons, what is the factor of safety in the rope?

ANS.—The bending stress in a rope or the stress due to the bending of a rope around a given sheave is calculated for the outer fibers of the rope, or for a single wire of the rope lying outermost in the curve, since it is this wire that is subjected to the greatest bending stress.

Bending stress in pounds per square inch to which the outer wire of the rope is thus subjected is given by the formula

$$S = E \frac{d}{D}, \quad (1)$$

in which,

S = bending stress (lb. per sq. in.),
 E = modulus of elasticity for steel (29,000,000),
 d = diameter of single wire of rope (inches),
 D = diameter of sheave (inches).

For the ratio of the diameter of the wire to the diameter of the sheave, or $\frac{d}{D}$, multiply the ratio of the diameter of the rope (1.25 inches) to the diameter of the sheave (108 inches) by the ratio of the diameter of the wire to the diameter of the rope ($\frac{1}{7}$ for 7-wire ropes. See page 90, *MINES AND MINERALS*, September, 1900). Then, for the bending stress, we have,

$$S = 29,000,000 \times \frac{1.25}{108} \times \frac{1}{9} = 37,294 \text{ lb. per sq. in.}$$

The sectional area of wire in a $1\frac{1}{2}$ " rope having 6 strands of 7 wires each (42 wires), when the diameter of each wire is $\frac{1}{7}$ of the diameter of the rope, is therefore

$$42 \times .7854 \left(\frac{1.25}{9}\right)^2 = 0.636 \text{ sq. in.}$$

Multiplying this area of cross-section by the stress per square inch (37,294 lb.) we obtain for the total stress due to bending

$$\frac{0.636 \times 37,294}{2,000} = 11.86, \text{ say 12 tons.}$$

This means that the rope, in its passage over the sheave, is subjected to a bending stress in its outer wires, equivalent to an additional load of 12 tons on the rope. When the actual net load upon the rope is 5 tons, the total load upon the rope including the bending stress, at the sheave, would be $12 + 5 = 17$ tons, and since the breaking strain of this rope is 70 tons there would result a factor of safety of $\frac{70}{17} = 4.12$, nearly.

M. B. SPAULDING, New York City.

Second Prize.—E. C. DAVIES, Duryea, Penna.

Coal Used in St. Louis, Mo.

Mr. Jas. Cox, Secretary of the Business Men's League of St. Louis, says in his report to the U. S. Geological Survey upon the use of coal in St. Louis during 1899:

As in past years, the great bulk of the inexpensive coal used in St. Louis came from the southern Illinois coal fields. The Illinois Central Railroad Company hauled in one-fifth of the entire supply, or almost identically the same tonnage as in 1898. The Wabash, the Louisville and Nashville, and the Louisville, Evansville, and St. Louis Railroads between them hauled in another one-fourth of the entire supply, as they did in 1898. The Baltimore and Ohio Southwestern Railroad brought in 13,600,000 bushels, as compared with 10,500,000 in 1898. The receipts from the Ohio River showed a considerable gain over last year, but did not amount in the aggregate to a million bushels. The St. Louis and Iron Mountain Railroad, which has been hauling in about 100,000 tons of coal from points south of St. Louis, returns no business in this line at all for 1899, and the St. Louis and San Francisco Railroad, which reported 25,000 bushels in 1897, reports only the nominal business of 850 bushels for 1899. The Missouri Pacific, which has in past years hauled in considerable coal from the points west of St. Louis, only returns 11,500 bushels for 1899, as compared with 61,000 bushels in 1897.

These figures seem to indicate that the prevailing low prices in the southern Illinois coal field shut out competition.

THE WARRIOR COAL BASIN

Of Alabama—Its Location, Geological Peculiarities, The Thickness of the Coal Seams, and Facilities for Transportation.

By Henry McCalley.*

The Warrior Coal Basin is not a very well defined area. It is the southwest end of the visible coal measures of the Warrior coal field. In contrast with the Plateau Region, into which it gradually merges on the northeast, it may be said to comprise almost all of the Warrior coal field that has higher strata than the hard sandstones and conglomerates near the base of the coal measures. As treated in the following report, however, it is not so extensive, but is limited by the outcrops of what might be termed the bottom workable coal seam (Black Creek seam) of this part of the field. By a workable coal is meant a seam of coal of two feet and over in thickness. This bottom workable coal seam (Black Creek seam), however, and much higher strata extend clear out to the southeast edge of the field, for a considerable distance, where the field is bounded on the southeast by a big thrust fault that engulfs all the lower coal measures and brings the upper coal measures in contact with lower Cambrian strata to the southeast of them. There are, nevertheless, in this part of the Warrior field several outcrops of coal of workable thickness of lower seams, and hence of seams of more extensive areas than the Black Creek seam, and it may happen that some of these lower seams carry considerable workable coal under the basin area.

The Warrior Coal Basin, as above defined, has along near its northeast boundary, the towns of Coaldale, Warrior, Quinton, Arkadelphia, Bremen, Natural Bridge, and Delmar; Tuscaloosa at its visible southwest end; Clements, Ensley, Pratt Mines, Mary Lee, Newcastle and Bradford, along near its southeast boundary; and Fayette C. H., Winfield, Pikeville and Hamilton near its visible western boundary. It, therefore, comprises parts of the counties of Jefferson, Winston, Marion, Fayette, and Tuscaloosa, and all of Walker. Its known area is something like 3,000 square miles. There is no way of telling how far its strata may extend to the southwest and west under the overlying Cretaceous and Tertiary formations.

This basin area is drained by the Black Warrior River with a general southwest trend, and its tributaries. This basin area, as a whole, is the northeast part of a broad shallow basin that has its southwest part hid under Cretaceous and Tertiary strata. This northeast part is not a simple regular basin, but is one that is more or less complicated by folds and faults. It is the northeast part of a broad, broken up, unsymmetrical synclinal with its deepest part or its thickest strata near its southeast edge. It has no very great depressions or elevations and the strata over most of its area are, in a general way, comparatively level. They are in gentle undulations and have a small angle of general dip to the southwest. This small angle of general dip of the strata is characteristic of the Warrior field when compared with the two other coal fields of Alabama. This dip, however, is greater than the surface inclination of the country and the fall in the streams, and so the strata increase in number towards the southwest. They continue to increase in this direction until they become covered up for good by the Cretaceous and Tertiary strata. They reach a thickness near their visible southwest end of nearly 2,000 feet over the Black Creek coal seam.

This basin area has, however, many local disturbances within it. Some of these disturbances are felt over considerable areas. It has extending down into it from the northeast the undenuded anticlinal of the Blountsville Valley and it has, cut off from its southeast edge by a complex fold with faults, a basin area that is known as the Little Basin. The rest of the Warrior Coal Basin, in contradistinction to the Little Basin, is known as the Big Basin.

The Blountsville anticlinal is felt for a long way down into the Big Basin area. It throws out over it or there has been washed away from over its top, the strata of the basin area as far to the southwest as Quinton, causing the outcrops of these strata to take a long detour to the southwest to get over the anticlinal or from one side to the other side of the anticlinal. The Little Basin of about 40 square miles in area has also extending down into it from the northeast an anticlinal fold. The low, broad anticlinal fold between the Big and Little basins is complicated, not only by faults but also by a narrow unsymmetrical synclinal along its crest. Its faults overlap each other with offsets towards the northwest.

The Warrior Coal Basin, as a whole, is also complicated, especially in its southeastern and southwestern parts, by transverse faults with a general north northwest and south southeast direction. These transverse faults, however, do not, as a general thing, have as great vertical displacements as the strike faults.

* Taken from the Reports of the Alabama Geological Survey.

The Warrior Coal Basin is made up, in the order of their abundance, of shales, sandstones, conglomerates and stone coals. The shales and sandstones form the great bulk of the strata. There is also at several horizons some little limestones and three to four seams of black band ore. The limestone, however, is not in thick beds like that of the coal measures in some other states and the black band ore is so uncertain as to both quantity and quality as to be considered of but little commercial value.

The coals are in from 2 to 5 regular seams in each of six groups, making in all twenty-three regular coal seams. The names of the groups, in an ascending order, are the Black Creek, Horse Creek, Pratt, Cobb, Gwin, and Brookwood. Only the two lower groups, the Black Creek and Horse Creek groups are to be found in the Little Basin. Each of these groups is named after its principal coal seam. These groups are separated from each other by on an average of from about 50 to 275 feet of barren strata. The two principal groups, the Horse Creek (Mary Lee) and Pratt groups, are the farthest apart of any two of the adjacent groups, being separated from each other by from about 175 to 375 feet of barren strata. The coal seams of the different groups are separated from each other by from 0 to 175 feet of strata.

The underlying coal measures of the Warrior Basin (those under the Black Creek coal seam), have an average thickness of some 1,400 feet with as many as fourteen different seams of coal. Only four, however, of these underlying coal seams appear to be always present and only two of them, and these two in only a few places appear to be ever of workable thickness in this basin area or in the southwest part of the Warrior coal field.

The regular coal seams treated of this field are therefore 23 in number. These regular coal seams, however, are increased in number in places by the splitting up of one or more of them into separate and distinct coal seams and are reduced in number in other places either by the coming together of two of them into a single seam or the complete dying out of one or more of them.

The coal seams, like the other strata of the coal field, will frequently so change from place to place on the outcrop within comparatively short distances of each other that the only safe way to identify for certain any one coal seam or stratum is to trace it out.

The sum total of coal in thickness is hardly the same in any two places. In a general way, however, in the basin area, it is greatest in the southeast outcrops and least in the northwest outcrops; the coal seams, in a general way, splitting up and thickening towards the southeast or towards the center of the original coal basin, and coming together and thinning out towards the northwest or edge of the original coal basin. For this reason, it is believed that when these coal seams have been correlated with those of the Cahaba field, the same seams as a general thing will be found to carry more coal in the Cahaba field than in the Warrior field, because the former field is nearer the center of the original coal basin. An attempt has been made to correlate some of the coal seams of these two fields. The sum total in the thickness of coals of the Warrior Coal Basin varies from about 10 to 115 feet.

The coal seams range in thickness from a few inches to some 16 feet. They are all more or less variable and no one of them is of workable thickness for the whole length of its outcrops. They all, however, with the exception of two, carry more or less workable coal on their outcrops. Four others, however, can barely be said to have any workable coal on the outcrops. Seven others are workable over not more than one-fourth of their outcrops; three others over perhaps about one-half of their outcrops and the remaining four over most of their outcrops. It often happens that as one coal seam thickens up one of those nearest to it thins out.

The sum total in thickness of the coals in the southeast outcrops varies from about 20 to nearly 120 feet, with a mean of about 60 feet; in the central part of the field, along the river, from about 20 to nearly 62 feet, with a mean of nearly 35 feet; and along the western edge of visible coals from nearly 13 to nearly 30 feet, with a mean of between 21 and 22 feet.

The most of these coals, when thick enough, can be mined with ease and cheapness. They were mined first in a systematic and scientific way, though in a small way, in 1872, on the Louisville and Nashville Railroad, near Warrior. Now, some two or more of the coal seams of each group, with the exceptions of the Cobb and Gwin groups, or 12 seams in all, are mined in a commercial way, and there are within this area some of the largest bituminous coal plants in the world. The mines that are now worked consist of considerably more than 12 shafts, 25 slopes, and 50 drifts. These mines, so far as known, are worked by the pillar and stall method, except in one single instance by the longwall system. Their annual output for 1898 was about 5,556,532 tons of coal.

The most of this coal is used within the State, nearly 2,000,000 tons of it being made into coke for iron ore smelting within the

State. The annual coke output from the coals of this basin was 1,480,605 tons in 1898. Some of the coke ovens are located at the coal mines and others at the furnaces.

The coals, though all bituminous, are of various kinds. They, as has been shown by use on a large scale, are suitable not only for making coke but also for steam, heating and gas purposes. Some of them are brighter and harder than others and so are better adapted for transportation.

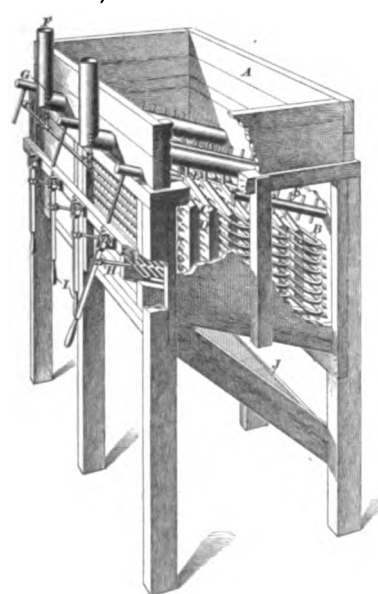
The Warrior Coal Basin has also seemingly almost inexhaustible quantities of fine building, paving, and curbing stones, and fine material (argillaceous shales) for the manufacture of vitrified bricks, tiles, etc. The building stones are often very homogeneous and 8 to 10 feet thick without a seam. The stones for the Government locks in the Black Warrior River at Tuscaloosa, magnificent pieces of masonry, were gotten from the bed of the river, in blasting out channels for the locks, and from the banks of the river close by. The paving and curbing stones with perfectly smooth and beautifully rippled marked sides can be gotten in many places, of almost any size and thickness. They are so uniform in places that they have received the name of plank rocks. The argillaceous shales occur in stratified beds up to 50 feet in thickness. They are manufactured into vitrified bricks, tiles, etc., of the best quality, at Coaldale. The most argillaceous of them, the underbeds to many of the coal seams, weather into an unctuous plastic clay that is very good potter's clay. These shale underbeds to the coal seams are usually very fossiliferous. The fossils are mostly of stem and leaf impressions of ferns, though some of them are of large specimens of calamites, sigillaria, etc. These large specimens, tree trunks, etc., have been seen in vertical positions extending up through the coal seams, and also standing upon the coal seams and extending up into the roofs.

The Warrior Coal Basin is still, for the most part, covered by its virgin forest of short and long leaf pines and the different varieties of hard wood (oaks, hickories, gums, etc.). It has also in it many fine sites for the erection of heavy machinery to be run by water power, the streams being often confined to narrow channels with rocky bottoms and sides.

Portions of this basin area have very good transportation facilities, though much of it is still far removed from any such means of development. To the railroads that cross and enter it on the north, east and south, should be added the Black Warrior River that has a length of over 100 miles within it. This river has plenty of water for perennial navigation for steam tugs and coal barges or for a minimum channel in extreme low water of 80 feet wide by 4 feet deep. Its first rocky obstructions, the most southwest visible strata of the great Appalachian system, are at Tuscaloosa. Congress, realizing the national importance of this river as a means of furnishing cheap coal to the Gulf of Mexico for sea-going vessels, placed its improvement at the last session on a continued basis.

The Howe Culm and Sand Dryer.

The Howe steam culm and sand dryer, as here illustrated, is a patented machine made by the Howe Manufacturing Co., of Scranton, Pa. It consists of a series of metal pipes *B* carrying live or exhaust steam, and arranged as shown, adjacent to metal ventilating chambers *C*, which stand vertically between the steam pipes.



THE HOWE CULM AND SAND DRYER.

The sand or culm to be dried is dumped into the hopper, or bin *A*, surmounting the steam pipes and ventilating chambers, and from thence it passes down between the steam pipes and ventilating chambers. The material in the hopper *A* is stirred by agitators *K*, which are moved by external handles shown at the left of the illustration. This stirring prevents the damp sand or culm from bridging or arching. As the moisture in the sand or culm is vaporized, it is drawn through numerous apertures *D* into the ventilating chambers *C*, then up through the connecting nipples *E*, and by the exhaust pipes *F* it passes into the air. Steam jets *G* placed

within the exhaust pipes *F* create a forced draft up these pipes.

After passing between the pipes and ventilating chambers, the dried material falls through slides *H*, which are provided with adjustable openings controlled by the levers *I*, upon separating or sizing screens *J*.

Although originally patented as a sand dryer, this device has been adapted for anthracite culm and fine coal. The culm as it comes directly from the bank, or small dirty coal from the mines, is usually moist and sticky, so that it clogs the screens in a coal washer or coal breaker. This, however, is obviated by first drying the coal, and by so doing the screens are left to do their work perfectly. All the mud-screen coal can then be saved from the waste dump. As an adjunct to a coal breaker, this dryer has been found to work very satisfactorily and to be especially advantageous in wet and freezing weather.

The dryer is also adapted to the handling of culm directly from the culm pile, and it so dries the culm that it can be readily screened and sized. In the process of sizing, the dust and dirt is completely removed, leaving the coal in excellent condition for the market. Culm prepared by this dryer will certainly have none of the objections raised against culm treated by the wet process—where large allowances have to be made for the weight of the water in each car—where the whole mass of fine coal is frozen solid, as often happens in cold weather, and the coal has to be mined from the car—where the water must be evaporated from the culm before the coal can be burned, and where the screens and all of the machinery are being constantly eaten away by the acidulated water.

The following results have been obtained with an experimental dryer which has been used in the vicinity of Scranton. The size of this dryer is 8 feet by 10 feet by 12 feet high, and the following quantities have been passed through it under the conditions given:

Experiment No. 1, August 15th, 1900.—With the slides controlled by hand, and with no pounder being used to hasten the flow of the material, 3,600 lbs. of coal were passed through the dryer in 30 minutes and the product was found to be well dried. This is the equivalent of 36 tons in 10 hours.

Experiment No. 2, August 15th, 1900.—Using a pounder and controlling the slides by hand, 3,120 lbs. of culm were run through in 30 minutes and found to be well dried. This is equivalent to 31.2 tons in 10 hours.

Experiment No. 3, August 15th.—With both the pounder and the agitator used, and with the slides controlled by hand, 5,220 lbs. were put through in 30 minutes and found to be well dried. This is equivalent to 52.2 tons in 10 hours.

Experiment No. 4, September 7th, 1900.—With the slides worked by hand, the pounder being used and with the agitator used over half the time, but rotated by hand, 4,500 lbs. were put through in 30 minutes, or 45 tons in 10 hours, but the culm was not well dried.

More detailed information concerning this dryer can be obtained from Mr. A. G. Thomason, secretary of the Howe Manufacturing Co., Scranton, Pa.

Use of Pea Coal.

Mr. S. R. Kirkpatrick railroad editor of the Philadelphia Press in his review of the Philadelphia coal trade for 1899 prepared for the reports of the U. S. Geological Survey says:

"The consumption of pea coal by the household grows larger every year, and in 1899 it was greater than ever before. This coal is cheaper and retails from \$1.25 to \$1.75 a ton below the selling price of egg coal and chestnut. Formerly it cost the dealer from \$1.10 to \$1.40 below the price of stove at the mines. It is used in a large measure by the passenger railway companies at their power houses, at the city pumping stations, at the water department, and in a number of instances by large manufacturers. The bulk of this coal, however, is sold by the dealers for domestic purposes. There was formerly great reluctance to use this coal, as it was full of dirt and slate, but recently the coal companies have made a number of improvements in the machinery for preparing it for the market, and it now comes to the dealer and consumer as uniform in size and free from slate and dirt as the so-called prepared sizes. Notwithstanding there is a disposition on the part of the coal companies to advance the price of this coal, there was little change made until December, 1899, when the price at the mines jumped from \$1 to \$1.75 a ton. At this time there was a good demand for this coal and the coal companies had trouble in filling their orders. Notwithstanding there was an increase in demand for this coal there was also more of chestnut size used, and this size is finding its way rapidly in every household. Pea coal was at one time more extensively used than it is now by manufacturers, but owing to the increasing demand for domestic purposes and a higher price the manufacturers are burning buckwheat coal, or what is known as No. 2 pea, and in many instances rice size is being used."

MINING WRINKLES.

For original contributions upon mining or metallurgical topics descriptive of new and handy devices and appliances we will pay at the rate of five dollars (\$5) per column, payment to be in technical or scientific books to be chosen by the contributor.

Sheaving on a Curve.

Wm. W. Core.

I have noticed that in some mines where tail-rope haulage is used there is often difficulty in sheaving the rope. In a certain mine I saw the guide rollers for a curve in the roadway placed as at *a b c d*, Fig. 1 (a); *g, h* and *i* were flanged rollers about 15 inches long, set across the track, and *e* and *f* just outside it. The sheaves on the curve were ordinary rope sheaves about 30 inches in diameter, which were set the same height as the tops of the rollers *g, h, i*. These were just high enough to keep the rope from dragging on the bottom. The couplings of the dump cars were almost

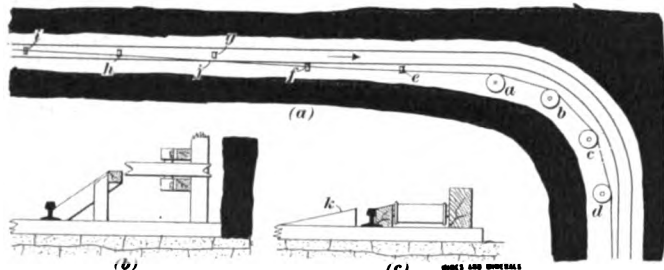


FIG. 1.

1 foot above this level, and as the two ends of the rope were hooked to the ends of a trip of about 50 cars, the rope was of course raised above the track at the ends of the trip. The trailer being raised made no difference on the straight road, because as soon as it became heavier than the angular pull would sustain, it again rested on the rollers without any watching or care; but when it came to the curve it was necessary to employ a rope rider to push the rope down so that it would go in the sheave, which it must do very close behind the car, or not at all.

This trouble may be avoided, and the rope rider removed, if the sheaves on the curve are placed just high enough, so that when the last car of the trip gets far enough around the curve to bring the rope over against the sheave, it will be a little below the sheave; and then place a guide as shown at (b) Fig. 1, which will lift the rope into the sheave.

When this ropeway was first installed, there was some bother, because when the trip passed, in the direction of the arrow Fig. 1 (a), if the trailer was a little slack, it would lie on the ties inside of the rail until the end of the trip passed around the curve, and would then catch against the rail as it (the rope) was pulled over by the cars. When the cars got far enough around the curve, the rope would fly out from behind the rail and go all the way over to the other side of the roller, at *f* and drag on the bottom and also saw the rail at *j* where it crossed. This of course would help to wear out the rope very rapidly as well as cutting a groove in the track, but this is not all: The quick and powerful jerk caused by the rope flopping from behind the rail also caused a severe strain on the engines and bull-wheel, as though the load had been suddenly removed and then replaced with interest. This was finally doctored by placing a wedge-shaped piece of wood as shown at *k* in Fig. 1 (c) and nailing it fast to the tie. This raised the rope out of the track and successfully prevented it from catching behind the rail. The side of the roller frame nearest the rail, was also sloped off to prevent the rope from catching on it; while the other side of the frame was made high enough to prevent the rope from jumping over it.

The main fault now existing with this arrangement is that very often the rope leaves the roller *g*, Fig. 1 (a), and the distance between *f* and *h* is so great that the rope drags on the rail, with the bad effect before mentioned.

In some mines these difficulties are overcome by sheaving the rope on small wheels placed between the rails on the curve as shown in Fig. 2 (a); but these must be placed low enough to clear the bottoms of the cars, and therefore require a rope rider to sheave them. A piece of iron with a spiral shaped hook at the bottom has also been tried and placed as at *l*, Fig. 3 (a) in the coupling

of the tail car after hooking it over the rope. The end of this rope was coupled to the third car from the end of the trip as shown, so that it was merely pressed down by the iron hook *l*, which was not subjected to any pull or other force. This iron, with the other devices also had its faults. If there happens to be some dirt or a large lump of coal in the roadway it will cause the tail car, on which the hook is, to jump the track. The device may work satisfactorily where the roadway is kept clean, but in some mines the men employed for this purpose do not accomplish it very fully, and so rather than run much risk, it is well to allow a fair safety margin for dirty roads.

I think that the arrangement shown in Fig. 3 (b) possesses several advantageous features. The curve sheaves are the same as those in Fig. 1 (a), but instead of being set out of the way so as to let the roadway make a simple curve, they are placed as shown so as to make the rope take the curve shown, while the rails are curved out of the way of the sheaves as shown. These sheaves

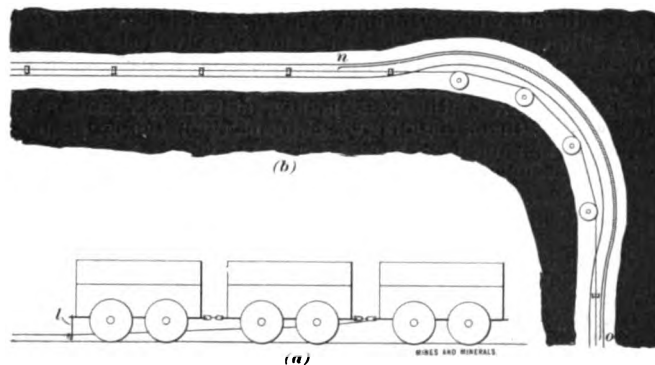


FIG. 3.

are also set up and have guides as explained for Fig. 1 (b). The track in clearing the sheaves curves out with a fairly long radius and then rounds the curve and comes again into the straight way. With this construction it will be plainly seen that the rope will run on the rollers all right and keep from dragging on the rail, and that all pull is central and natural except when the trip is going around the curve, which stretches the rope out to the center of the roadway and causes it to pull the cars sideways, which might cause them to jump the track if some means were not taken to prevent; but the preventative is at hand, and has been tried and found thoroughly practical.

A section of the roadway on the curve is shown in Fig. 2 (b), which shows the means used to keep the cars from jumping the track. It is merely a very heavy strip of sheet iron *m* standing on its edge inside of the outside rail. It extends all the way round the curve from *n* to *o*, Fig. 3 (b). It is kept in place and strengthened with wooden braces *p*, Fig. 2 (b), to which it is fastened with flush screws or spikes. The braces *p* are fastened rigidly to the ties. When the car is pulled sideways so hard that it would jump the track ordinarily, the worst it can do, with the strip to guide it, is for the flange of the inside wheel to ride upon the rail, and even this will be prevented if the strip *m* is placed near enough to the outside rail and the rails are not too close together.

Specially designed grip cars might have been used on one or both ends of the trip, to overcome the above difficulties; but I think the cost of equipment, as well as that of maintaining and handling, would go decidedly against them, in favor of so constructing the road that they would be unnecessary.

Water Filtration.

By T. N. Thomson

In some mining districts it is almost impossible to get a drink of good clear water after a heavy shower of rain until the reservoirs have had time to "settle." The greater part of the water consumed in cities for drinking and cooking purposes, becomes contaminated on its way to the reservoirs, and often in the reservoirs themselves. Not only does the pure rain water absorb mineral impurities as it travels down the hill or mountain sides, but it often becomes highly impregnated with mud, decayed vegetation, and even with the excrement from sheep and cattle. Most of the matter held in suspension settles on the bottom of the reservoir, and the water, when allowed to stand, ultimately becomes fairly clear before it enters the main pipe lines. A reservoir may, however,

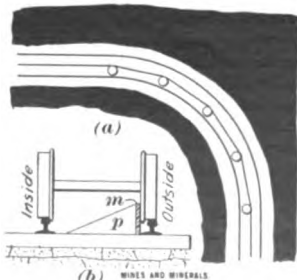


FIG. 2.

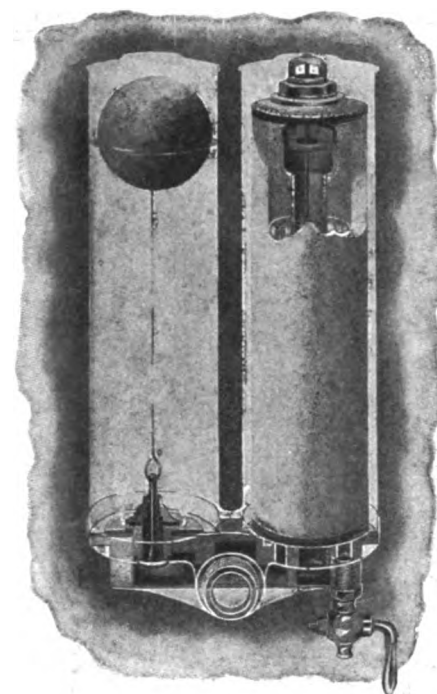
become so turbid throughout after a heavy shower that it is no uncommon occurrence for the muddy water to enter the street mains and be drawn from the faucets in that condition.

Many reservoirs, it is true, are equipped with filters, but very often these are so constructed that they can intercept only such objects as branches of trees, twigs, dead cats, etc., and are of no use whatever either in intercepting germs of disease or in clarifying the water.

Sand and gravel filters do not, and cannot, intercept bacteria, for the spaces between the filtering material are large enough to let these minute organisms go through a hundred abreast, if such a thing could be imagined. If water companies would place germ-proof filters at their reservoirs that would not only intercept germs but also clarify the water as clear as crystal, and if the street mains could be kept thoroughly clean inside, there would be no use at all for the public troubling about the quality of the water used in their homes, because it would come to them perfectly clear, pure, safe and wholesome. But water companies will not do this, and the public does not seem to care much whether they do it or not.

If disease germs are to be filtered from water, it is necessary that the filters operate very slowly, because the filtering material must be so close that the water will simply ooze through it, even when subject to high pressure, and its surface must be large, so that the quantity exuded, when collected, will form at least a small stream.

A new filter that is now being placed on the market seems to be built on proper principles. It is composed of two nickel-



plated polished casings; the one on the right hand surrounds the filtering tube, while the one on the left serves as a reservoir for filtered water. This attachment filters from 15 to 50 gallons a day, according to the pressure. The main object of the reservoir is to hold in reserve a supply of drinking water that, though limited, is always ready when wanted. The interior of the filter is lined with block tin to prevent the water stored there from being contaminated with metallic poisons. It is 12½ inches high, and weighs about 8 pounds complete. The filtering tube is a hollow cylinder made of specially prepared, fine, porcelain composition. The water from the sink faucet, which is used to draw off un-

filtered water for ordinary purposes, is employed to keep the filtered water cool. This filter is made to be screwed on the cold water pipe at the kitchen sink and is so constructed that every time water is drawn from the sink faucet, a current is made to circulate around the filtering cylinder, thus keeping the cylinder clean and its contents cool. The manufacturers claim that this flushing action thoroughly cleans the filter, thus making it automatically self-cleaning. The price of this modern filter is \$12.50 and we do not know of any filter more worthy of a place in the home than the one shown here, which is made by The Metropolitan Filter Company, 97 Washington Street, Chicago, Ill., to whom we are indebted for the illustration.

In rating mineral as manganese ores or as manganiferous iron ores the distinction which has been generally accepted is made on a content of 44% manganese. That is, ores which when dried at 212 degrees contain 44% or more of manganese are classed as manganese ores, while those carrying smaller percentages are rated as manganiferous iron ores unless they have less than three per cent. of iron. Treasury Decision 4,114 provides that ore to be classed as manganese ore must contain 50% or over of manganese and not over 10% of iron. Treasury Decision 16,550 modifies this and allows certain ore containing less than 50% of manganese to be classed as manganese ore when the iron contained was less than 3%.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

- SCULLY STEEL AND IRON CO., Chicago, Ill. 120 pages.
- STEAM ENGINES. The Brownell & Company, Dayton, Ohio, 32 pages.
- AMERICAN COPPER MINING AND EXTRACTION COMPANY, Denver, Colo. Catalogue 15 pages.
- ABOUT MINE CAR HITCHINGS. William Harris & Son, 111 Ferry St., Pittsburg, Pa. 12 pages.
- RIEDLER DUPLEX AIR COMPRESSOR. Fraser & Chalmers, Chicago, Ill. 1 page circular.
- COAL WASHING EQUIPMENTS. Jeffrey Mfg. Co., Columbus, Ohio. 88 pages copiously illustrated.
- ELECTRIC MINE LOCOMOTIVES. General Electric Company, Schenectady, N. Y. No. 1030. 46 pages.
- STEEL WHEEL BARROWS, LUMBER CARTS AND BUILDING IRON WORK. Archer Iron Works, Chicago, Ill. 12 pages.
- CAREY'S ASBESTOS FURNACE AND STOVE LINING CEMENT. The Philip Carey Mfg. Co., Lockland, O. 1 page circular.
- STEAM BOILERS. Catalogue No. 48. The Brownell & Company, Dayton, Ohio. 55 pages very handsomely gotten up.
- THE RIGG POWER-DRIVEN COAL TIPPLER. Rigg's Coal Tippler, Limited, 11 Queen Victoria St., London, England. 3 page circular.
- THE WESTINGHOUSE 12A RAILWAY MOTOR. Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Circular No. 1035. 12 pages.
- COAL HANDLING FOR STEAM GENERATION. C. W. Hunt Co., West New Brighton, New York. 40 pages handsomely illustrated.
- HOOPER PNEUMATIC SYSTEM OF CONCENTRATION. Hooper Pneumatic Milling Co., 517 W. 30th St., New York City. 16 page circular.
- A MODERN CORLISS ENGINE. The Lane & Bodley Co., Cincinnati, Ohio. A paper read before the Convention of Cotton Seed Oil Mill Superintendents at San Antonio, Texas. 8 pages.
- WESTINGHOUSE MOTOR-DRIVEN AIR COMPRESSOR. 22 pages. A neat catalogue of air compressors especially designed for operation by electric motors. Issued by the Westinghouse Air Brake Company, Pittsburg, Pa.
- 2500 WITNESSES. B. F. Sturtevant Co., Boston, Mass. A List of buildings and sundry steamships wherein the Sturtevant system or apparatus has been installed for purposes of ventilation and heating. 56 pages.
- THE STEAMLOOP AND HOLLY GRAVITY RETURN SYSTEM. Westinghouse, Church, Kerr & Co., 26 Cortland St., New York City. 55 pages giving handsome illustrations of numerous plants at which this system is in operation.
- REVERSIBLE MOTORS. Erie City Iron Works, Erie, Pa. 8 page circular. Also the Slade System of Gathering from Rooms, 4 page circular; An Innovation in Mining Machines, 4 page circular. 1 page circular of Mine Locomotives and Coke Larries.
- THE ROYAL ROCK AND ORE CRUSHER. Diamond Drill and Machine Co., Birdsboro, Pa. 36 pages describing the Royal crusher and giving price list. Also, by same firm, "The Diamond Drill and Its Work," 28 pages describing their diamond drill and supplies.
- THE STURTEVANT ENGINE CATALOGUE No. 103, B. F. Sturtevant Co. 50 pages. A very tastefully gotten up catalogue giving descriptions and views of various styles of engines and generating sets made by this company. Also, "The Sturtevant Exhaust Head," 4 page folder by same company.
- MINE SUPPLIES. MINING TOOLS, HARDWARE. C. Trautman Co., 1803 Carson St., Pittsburg, Pa. 78 pages. A very neat pocket catalogue containing all of the smaller tools and appliances needed about a mine, also circulars describing an Emergency Box, the Huston Oiler, and the Twentieth Century Oiler.
- GENERAL ELECTRIC COMPANY, Schenectady, N. Y. Type H Subway Transformers, Bulletin No. 4234, 5 pages. Rotary Converters for Railway Systems, Bulletin No. 4233, 7 pages. Polyphase Transmissions for Electric Railways, Bulletin No. 4235, 17 pages. Direct Connected Railway Generators, Bulletin No. 4236, 9 pages. The GE-73 Railway Motor, Bulletin No. 4237, 5 pages. Interchangeable Arc Lamps. Pamphlet 6 pages. The Series Alternating System in Practical Operation. Pamphlet, 9 pages. Aging of Transformer Iron. Catalogue, 89 pages. 1 page circulars describing Pendant Push Button Switches, Flush Pocket Snap Switch, Combined Socket and Attaching Plug, Principal Renewal Parts of Direct Current Enclosed Arc Lamps.

Krupp Industries.

From the 1899 report of the Krupp steel plant at Essen some very interesting information is obtained regarding the magnitude and capacity of the Krupp organization. During the year 1899 the firm of Krupp comprised the steel plant at Essen; the steel works at Annen, Westphalia (formerly F. Asthove & Co.); the Gruson plant at Magdeburg-Buckau; the blast furnaces near Duisburg, Neuwied, Engers and Rheinhausen (the latter possessing three furnaces, each of 230 tons per diem capacity); a plant near Sayn; for coal mines (viz., Hanover shafts 1, 2, 3, and 4, and the Salzer and Neuack shafts), besides part ownership in various other mines; more than 500 iron ore properties in Germany, of which 11 are deep shafts fitted with mechanical equipment; various deposits near Bilbao, Spain; shooting grounds near Meppen, 16.8 km. in length, with an actual firing distance of 24 km.; three ocean steamers, several stone quarries and clay and sand deposits, besides the control and operation of the Schiffs- & Maschinenbau-Aktiengesellschaft "Germania," at Berlin.

The principal articles of manufacture at Essen are ordnance, ammunition, gun barrels, armor plate for all protected parts of war ships as well as for fortifications, iron and ship building material, machine parts of every sort, rails, iron and steel plates, rolls, tool steel, etc. The Essen plant is divided into the following departments: Two Bessemer works, containing altogether 15 converters; four Martin works, two steel casting works, puddle

the steel plant amounted to 15,018,156 c. m., or as much as is required by the city of Frankfurt-on-the-Main. The combined length of the water pipe was 171.59 km., that in the buildings 106.48 km. The consumption of gas for lighting purposes amounted to 18,836,050 c. m. (the consumption of the city of Leipzig for the same period was 21,931,140), the same supplying 2,596 street lights and 41,745 lights in the works.—*Kuhlows.*

American Steel & Wire Company at the Paris Exposition.

The American Steel & Wire Company's exhibit at the Paris Exposition was one of the most complete and interesting of the entire show. The installation was in the department of Mines and Metallurgy, and was not placed with the other exhibits from the United States for lack of space.

On the main floor the exhibit occupied a space 50 × 50 feet. It comprised iron ores and coal from the company's mines in Michigan, Minnesota, Wisconsin and Pennsylvania; limestone from its quarries; coke from its ovens; pig iron from the blast furnaces. The quality and nature of the pig iron was illustrated by fractures; ingots, blooms and billets from Bessemer and Open Hearth steel mills.

All the above were compactly grouped near the entrance to the exhibit. In the center was an ornamental bronze pagoda with art glass roof in which pagoda were panels illustrating various



PART OF AMERICAN STEEL AND WIRE COMPANY'S EXHIBIT AT THE PARIS EXPOSITION.

works, crucible steel plant, welding mill, foundries, works for casting guns and brass, annealing shops, hardening halls, crucible chambers, block rolling mill, rail rolling mill, plate mill, bolt and spring steel works, spring machine shop, hydraulic press plant and armor plate rolling mill, hammer works, wheel foundry, tire rolling mill, boiler shops, field railway construction shop, mechanical workshops (with file factory), four repair shops, railway machine shops, gun and ammunition shops, testing laboratory, two mechanical laboratories, one physico-chemical testing laboratory, boiler house, electrical plant, gas works with one plain and two telescope gas tanks, holding respectively 5,700, 17,500 and 37,500, altogether 60,700 c. m.; water works with three separate sources of supply, factory for fire brick and briquettes, brick kiln, lithographic and photographic establishments, together with a book bindery, freight office, telegraph, telephone, fire and safety departments and food supply stores.

At the mines an average of 1,877 tons constituted the daily output of ore, while the production of coal in the mines proper averaged 3,738 tons per diem. Coal and coke were consumed at the steel plant to the extent of 952,365 tons. The total consumption at the remaining works was 622,118 tons, or in all 1,570,483 tons—5,000 tons daily. The consumption of water at

manufactured products such as sections of beams, channels, angles and bars; sections of shafting, rail splices and frog filling; horse shoes, spikes, nails and tacks, barbed wires, bale ties, fine copper wires, music wires, fine spooled wires, all sorts of chains and rivets, coiled, spiral and flat springs, clock springs, wire ropes, insulated wires and cables, sections of sub-marine cables, etc.

In the space surrounding the pagoda were samples of sheet steel with illustrations of quality in the shape of cold bending and stamping tests, large steel boiler heads, many bundles of woven wire fences and galvanized poultry netting. Piled in attractive pyramids were wire rods, steel and copper wire in bundles, and on reels copper trolley wires; weatherproof and lead encased cables; copper rail bonds, wire ropes, and so on ad infinitum. The astonishing feature of the exhibition was the great variety of products shown. The entire range of the steel producing industry appears to have been covered by the products of this company, which is popularly, but erroneously, supposed to be confined to the wire industry.

The gallery or auxiliary exhibit consisted of forty large panels, 6 × 5 feet, on which were artistically grouped products of the various departments, while in glass cases beneath the panels additional samples and test pieces were shown, the entire square being

surmounted with fifty large photographic reproductions or bird's-eye views of the various mines, furnaces, steamships and manufacturing establishments owned and operated by the company.

The entire exhibit was a credit to the American Steel & Wire Company. It was designed and arranged under the personal supervision of Mr. P. W. Moen, 3d Vice President, and Mr. F. H. Daniels, Chief Engineer. It was entirely set up, before shipment to Paris, in the Worcester plant, then taken down, shipped and re-constructed on the other side.

Prize Awards.—It is not to be wondered at that so complete a showing should be rewarded with high honors. The American Steel & Wire Company received more Grand Prizes and Gold Medals than any other American exhibitors, the awards being as follows:

Four Grand Prizes (the highest possible award), two gold medals and a collaborative gold medal each to President Palmer and Chief Engineer Daniels, expressive of appreciation of their share in making such a showing for their company. The detailed awards were:

One Grand Prize, Class 26. The highest possible award, for iron and steel galvanized telegraph and telephone wires, pure copper wires, insulated conductors, rail bonds, trolley wires, feeder cables for light and power, aerial, underground and submarine cables.

One Grand Prize, Class 7. Music Wire, for greatest tensile strength, ductility and high finish.

One Grand Prize, Class 63. Covering metallic ores, coal and coke, also natural mineral paints such as venetian red and coppers, of which this company is the largest manufacturer in the world.

One Grand Prize, Class 64. Covering pig iron, steel in ingots, bars, sheets, finished plates and wire rods; also copper and copper alloys, ingots, bars, etc.

One Gold Medal, Class 30. Covering bicycle and carriage wire spokes and kindred products.

One Gold Medal, Class 65. A general metallurgical class, including wire nails and tacks, barbed wire, wire rope, horse shoes, woven wire fencing, springs, chains, staples, wire netting, and kindred products of the wire industry.

A Grand Prize was voted on Class 65, but withdrawn because a Grand Prize had already been awarded in Classes 63 and 64, which being so closely related to Class 65, it was considered a crowding of honors to award another prize in this class.

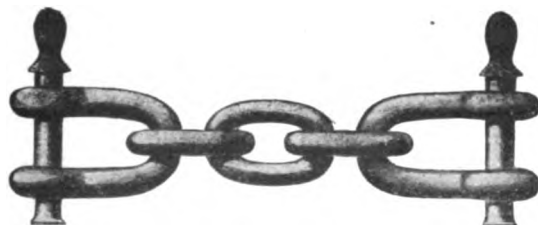
One Gold Medal to Wm. P. Palmer, President American Steel & Wire Company.

One Gold Medal to F. H. Daniels, Chief Engineer American Steel & Wire Company.

Mine Car Hitchings.

Since the advent of the mine locomotive permitting the use of heavy cars and long trains, expensive and dangerous wrecks have been frequent. Many times the causes of these have been directly traceable to defective hitchings.

This fault has been brought to the attention of different manufacturers with the result that some firms are devoting their entire attention to the manufacture of mine car hitchings or couplings. One of the largest of these concerns is that of Wm. Harris & Son, of Pittsburg, which during the past ten years has made a specialty of couplings for mine cars. These years of experience in the making of hitchings and the fact that they are thoroughly conversant with the different qualities of iron enable them to select material which is best adapted for this use. Workmen employed exclu-



sively on this class of work gain an experience which the usual run of mine blacksmiths do not have. They are required to pay the closest attention to details; every link being hand welded by men who know the difference between burning iron and getting it hot enough to weld. Men working on one class of work are able to reduce the cost of manufacture, and the economical side is no small feature.

In this manner William Harris & Son's hitchings overcome the annoyance and danger of wrecks incident to the use of inferior couplings and at a cost practically the same as is often charged for an inferior article. Further information can be obtained from an interesting pamphlet which will be sent free of charge by William Harris & Son, 111 Ferry St., Pittsburg, Pa.

SOME METALLURGICAL FEATURES

Of the Paris Exposition—The Minerals and Metals Shown in Various Forms by the Different Countries.

Written for MINES AND MINERALS, by Dr. Joseph W. Richards, of Lehigh University.

It is manifestly impossible, in a short descriptive article, to describe all the metallurgical features of interest displayed at Paris, even granting that one had the rare fortune to have seen them all. One of the severest criticisms on this branch of the exhibition was the imperfect classification, which made it almost impossible to find all the displays of a given metal or in a given line. After six weeks spent in Paris this summer the writer has a lingering suspicion that there were many metallurgical "sights" there which he may not have set eyes on. It will evidently be to the interest of the readers of this article, moreover, to confine these remarks to the particular features which merit most attention.

The Palace of Mining and Metallurgy, which contained many, but by no means all, of the exhibits of that class, was a beautiful building of imposing dimensions and artistic exterior, situated on the east side of the Seine about a hundred yards from the east pier of the Eiffel Tower. Many of the exhibits were in the buildings immediately on the bank of the Seine north of the tower.

In general, we may say that France was magnificently represented. Her firms vied with each other and with the rest of the world in showing to greatest advantage the metal industry of their country, and clearly carried off the general honors for elaborateness and artistic arrangement of their displays, while the quality of their products was in many cases of the highest. The United States was mostly conspicuous by its absence. With a few exceptions, our great metal industries were inadequately represented, some of our largest concerns, whose output would equal nearly that of the whole of France put together, being outdone by half a dozen French exhibitors.

Iron and Steel.—Considering first the ores; besides the usual minerals to be expected there was shown in the exhibit of the French colony of New Caledonia a form of limonite ore carrying 3 to 5 per cent. of chromic oxide. This ore is said to occur there in immense quantities, and is important in view of the recent developments in chromium steel. It is interesting to remark that some specimens of limonite recently brought from Cuba show a somewhat similar content of chromium. Algiers and Madagascar also showed fine exhibits of ores. Canada was well represented, the display calling renewed attention to her immense titanic-iron-ore deposits, which may in the near future become valuable.

In the steel business, French and foreign exhibitors showed very generally nickel-steel. Alloys of steel with up to 25 per cent. of nickel are being made and put into use for special purposes; one cable of such material showing an ultimate tensile strength of 300,000 lbs. per square inch. Low carbon nickel-steel containing small quantities of copper was exhibited, the tests showing it to be a fine metal. Low carbon chromium steel, made by using pure chromium, proves to be one of the best of the special steels. The Crescent Steel Company, of Pittsburg, showed one of the finest exhibits of tool-steel at the exhibition. The exhibit of the Penn-coyd Iron Co., illustrating its bridge and construction work, was deserving of the great attention it attracted. The finest single exhibit of steel work was undoubtedly that of Schneider of Creusot. It was housed in a huge beehive-shaped building, painted outside to represent a huge fort, and containing inside a magnificent exhibit of guns, armor, ship-shafts, and an immense express locomotive, designed to pull a train at ninety miles an hour. This immense engine had two cabs, the engineer's being in front by the smokestack, and has wind-shields. The use of wind shields is quite general on French express locomotives, on the boiler front and smokestack.

Copper.—Fine exhibits of copper ores were made by New Caledonia, Algiers, Canada, and Mexico, besides the larger copper-producing countries. Of the exhibits of copper itself, its large use for steam boilers in Europe was shown by the number of locomotive fireboxes in copper, exhibited. It is curious, to say the least, how sharply American and European locomotive practice differ on this point. The sheets for making these boxes, as also for sugar-pans, were fine samples of rolling. Particularly noticeable, also, were groups of immense copper tubes, three feet in diameter by ten feet long, and half an inch thick, deposited in a solid mass by the Ellmore electrolytic process. This process consists in depositing copper by electrolysis on a revolving core, and rolling it solid by small rolls as it is deposited. The tubes and cylinders thus formed have great toughness and reliability, and the process has gone into large use in England, France, and Germany, but appears not to have taken root at all in America.

Aluminum.—Here France shared the honors with England, while the manufacturers in Switzerland and the United States were barely represented. The British Aluminum Company had a very creditable exhibit, showing how extensively the metal has gone into use for chemical, mechanical, electrical, and household uses. Among the interesting articles shown were large stills for distilling acetic acid, portable water sterilizers for army use, carriage bodies and shafts, automobile castings, dynamo-frames and motor cases, cables for electrical transmission (for which purpose this metal is now cheaper than copper), etc. Among the exhibits of the French company were pulleys, gun-carriage parts, dynamo-frames (up to 400 pounds in weight); funeral wreaths, which are used extensively in France and Italy; and very large sheets, for lithographers' use. In the German section the process of Goldschmidt, of Essen, whereby iron is welded by means of aluminum, was shown, the tests appearing eminently satisfactory as applied to welding rods, tubes, and even rails. The process consists in mixing powdered aluminum with iron oxide and setting fire to it in a crucible. The white-hot iron which is obtained in a few seconds, together with the melted aluminum slag, is then poured around the joint to be made. Its temperature is so high that the joint is melted into a perfect weld. The same exhibitor showed pure metallic chromium, manganese, and tungsten, and alloys of iron with these and other rare metals, such as molybdenum, titanium, vanadium, and uranium, all made by mixing their oxides with powdered aluminum and igniting the mixture. These rare alloys are mostly used in producing special kinds of steels, and this method has proved by far the easiest and most practical way of obtaining them.

A process of welding aluminum was shown by the platinum worker Heraeus, of Hanau, Germany. Joints of complicated apparatus were shown perfectly welded, without the use of solder or flux, by a method of autogeneous soldering; that is, by heating the parts up very carefully to a temperature at which they commence to soften but do not become brittle or granular, and then hammering together. The work was so well done, and is stated to be so easy to learn, that it is likely to come into considerable use in manufacturing articles of aluminum, as the process is for most purposes far to be preferred to soldering.

Nickel.—The display of nickel ores, from New Caledonia, was large and interesting. The yearly production of nickel ore in this French colony surpasses 100,000 tons; being in every case various forms of the hydrated silicate of magnesium and nickel. A pamphlet of the Caledonian Agricultural Union gives a very complete and interesting account of the discovery and smelting of nickel ores on that island, from which is condensed the following details: Jules Garnier, head of a French scientific expedition, discovered the deposits, in 1865, the mineral being named in his honor "Garnierite." He developed the deposits and founded the industry. In 1874, the Coste Brothers, colonists, discovered still larger deposits, and founded another society. Both societies exhibited at Paris in 1878. In 1880 the two were united under the name of the "Société Le Nickel." This society is still in existence. The nickel ores are smelted at the works at Nouméa (the works established by the second society) to crude nickel and nickel matte. These products are sent for further treatment to works in Iserlohm, Germany, and Glasgow, Scotland. A third refining works formerly operated by the company in France, is now closed.

The bright apple-green silicate ore contains on an average 20 per cent. of water and 5.6 to 5.8 per cent. of nickel. It is smelted in cupola furnaces, with coke and limestone. The crude nickel produced daily is 2.5 to 3 tons, besides some nickel sulphide (matte). The crude nickel contains much carbon and iron, and is called by the French "fonte de nickel" or "cast nickel" because of its analogy to cast or pig iron.

The principal exhibitors of nickel at Paris were the Société Le Nickel, above alluded to, the Société Ferro-Nickel and the Oxford Copper Company of America.

The Société Le Nickel showed ores, raw products and refined nickel, in sheets for culinary utensils and coinage, in wire for ornamental use, in slabs for anodes in electro-plating, etc. They also gave particular attention to nickel-steel, made by various French steel works. This has proven one of the largest uses for nickel ever discovered, particularly when it is known that some works are making and selling alloys of steel with as much as 25 per cent. of nickel. Their output amounts to 4,000 tons a year.

The Société Ferro-Nickel showed nickel-steels, alloys of steel and nickel up to 40 per cent. nickel, and their particular alloy *ferro-nickel*. The latter is a nearly carbonless alloy of soft iron with 40 to 75 per cent. of nickel, and is a beautiful white, strong, rustless alloy, looking like pure nickel.

The Oxford Copper Company works the nickel matte obtained from the nickel-bearing magnetite-pyrite deposits of Sudbury, Canada. In Canada, the ore is smelted down to a matte or sulphide of nickel, copper, and iron, which is worked to pure

nickel at Constable Hook, near New York. Besides nickel oxide and pure granulated nickel, this company also exhibited, for the first time, electrolytically refined nickel, which attracted much attention. Only practical electro-metallurgists appreciate the difficulty of electrolytically purifying nickel, and this exhibit of huge slabs of nearly pure nickel, thus obtained, marked a great advance in the metallurgy of this somewhat refractory metal.

Gold.—Almost all the gold-producing countries were represented by collections of their ores. From Alaska, the Canadian exhibit contained dust, grains, and models of nuggets. West Australia was represented by a splendid collection of minerals, among which are unexpectedly fine specimens of the telluride ores, similar to the famous Cripple Creek, Colorado, ore. These ores are from the richest district, the East Coolgardie field, from which over fifteen million dollars worth of gold was taken in 1898. The specimens contain, mineralogically, calaverite, and sylvanite, besides the rare mercury telluride, coloradoite. The resemblance to Colorado ores, and the richness of the field, are striking.

The Transvaal Republic, taken in connection with the Siemens-Halske Company, had the most interesting gold exhibit. The gold mines of the Transvaal were represented by a mining exhibit in full operation, situated near the Trocadero Palace, consisting of shafts and passages underground, illustrating on a large scale actual mining operations, from which was extracted actual gold ore brought from the Transvaal and previously put in place. This ore was put through crushers, stamps, and amalgamated. The residues were passed over Frue vanners, the concentrates put aside for treatment by the chlorine process and the tailings sent to the cyanide plant. This latter was put up by the Siemens-Halske Company in connection with the Rand Central Reduction Company of Johannesburg, and showed on a very practical scale the working of this important process. The tailings were run into sheet-iron tanks, and each ton treated with $\frac{1}{2}$ ton of 0.05 to 0.1 per cent. potassium cyanide solution, during five to seven days. The gold-bearing solution is drained out through a filter of cocoa matting on the floor of the tank, and run into the electrolytic depositing tanks. The latter contain anode plates of sheet-iron, between which are hung cathodes of sheet lead cut into strips and twisted into ringlet-like shapes in order to give greater depositing surface. A current of one-half ampere per square meter of electrode surface is used, and a current of 100 amperes by 14 volts treats 50 cubic meters of solution a day. Every month the lead strips are taken out and melted down to bullion containing 1.5 to 10 per cent. of gold.

It is well known that the cyanide process is not applicable to all kinds of ores, especially such as contain gold in nuggets, or much copper, but it can very usefully co-operate with other processes, as the amalgamation process, for instance, and the complete installation we have been describing made the Transvaal exhibit one of the most interesting metallurgical features of the exhibition.

Mercury.—The only large works represented was the Austrian, from Idria. A pamphlet describing the present condition of this industry, by von Ernst, contains some interesting details. Five shafts are now being worked, the deepest 287 meters. The average content of mercury was many years ago 12 per cent., in 1880 it fell to one per cent. and in 1898 was down to five-eighths of one per cent. The ore is roasted in the well-known Idria furnaces. The amount of ore treated in 1898 was 90,000 tons, affording 550 tons of mercury, the cost of smelting which amounted to $7\frac{1}{2}$ cents per pound. The 220 men employed in the smelting works change with the miners, to avoid chronic mercury poisoning; so that, on an average, each man works at the smelting only one month out of six. The workmen live mostly in the company's houses, while medical attendance, schooling for the children, as well as instruction in wood-carving, drawing, music, and the trades is furnished free. The establishment is as interesting from the standpoint of industrial economy as it is ancient as a metallurgical plant.

Uranium.—Outside of some few mineralogical specimens from the United States, seen in the collection of our mineralogists Foote and English, the only specimens of uranium ore metal and salts were those in the Austrian collection. The production and uses of this metal and its oxides and salts are increasing rapidly; forty tons found last year in Colorado brought a market price of over five thousand dollars a ton, in New York. The ore there is yellow silicate.

At Joachimsthal, in Austria, 180 workmen are employed in mining and working the uranium ores. The yearly production is 45 tons of uranium ore, mostly pitchblende, which is concentrated by hand up to 55 per cent. material. In view of the increasing interest in uranium, a sketch of the further treatment is interesting. The concentrates are crushed, roasted 15 hours to remove sulphur and arsenic, then mixed with soda and niter and roasted to the formation of the sodium salts of uranium, vanadium, etc. The mass is cooled, ground, washed with water, and the uranium remains in the residue as sodium salt and oxide. This residue is treated with strong sulphuric acid, which dissolves out the

uranium. (The residue contains silica, lead sulphate, etc., and it is in it that the Parisian chemist Curie has found the two new elements Polonium and Radium.) Silver is precipitated from the solution by adding common salt and filtering; the solution is then neutralized with soda and brought to boiling, when calcium carbonate and iron oxide precipitate and are filtered out; it is then neutralized again with sulphuric acid, when a carbonate of sodium and uranium precipitates, which is filtered out, washed, dried to a bright-yellow powder and sold as Uranium-Soda, No. 1; containing 80 to 82 per cent. of uranium oxide. The other uranium oxides and salts are either produced from this or from a nearly similar treatment of the ore.

Uranium salts are used for coloring glass, and in dyeing; uranium oxide in producing ferro-uranium, for use in special steels.

Platinum was represented in quantity only in the Russian section. Three companies were represented, one showing a silvered cast of the largest nugget of platinum ever found, accompanied by beautiful specimens of emeralds and other minerals found in the Urals. Russia supplies 97 per cent. of the production of the whole world.

Samples of the ores of zinc, tin, chromium, molybdenum, antimony, lead, and silver were to be found in the exhibits of many countries, but were mostly without particular interest except it may be those of the Vielle Montagne Zinc Co., the largest zinc company in the world. Besides the ordinary exhibits of ores, metal, photographs, and statistics, there was nothing of particular interest.

To conclude, many of the metallurgical and mineralogical exhibits were of the highest interest, but no one metal was as thoroughly represented as might reasonably have been expected, and many countries, the United States among them, were very inadequately represented. France in general showed up splendidly in every branch of the metal industry she is concerned in, for which enterprise we congratulate heartily her metal workers.

Marcus Daly.

Written for MINES AND MINERALS, by DON MAGUIRE.

Marcus Daly, Montana's Copper King, who for 20 years largely owned and almost wholly controlled and managed the great Anaconda and St. Lawrence copper mines of Butte, Montana, died in New York City of Bright's disease on the morning of November 12th, 1900. Mr. Daly was a man remarkable for the wonderful success he achieved in managing the immense copper mines of Montana.

He was a native of County Cavan, Ireland, and at the time of his death was 59 years of age. Born and reared on a farm in his native country, he had but few advantages thrown before him in early years. His education was such as a rustic school could impart between the ages of 8 and 14 years. He stole away from his home in Ireland at the age of 15 years, and reaching New York, he became for a time a dock hand.

Mr. Daly went from New York to California, in which state he achieved no particular success, but was a man of all work or common laborer. He drifted to Nevada where he became interested in mining simply as a man working in the mines, and in the Comstock at Virginia City, he obtained his first knowledge of quartz mining. Being naturally of a very observant turn of mind, he soon became conversant with the nature of mineral veins and everything pertaining to their value for future working. In the early 70's he visited Utah and became a mine foreman, successfully managing work at Ophir, Dry Canyon, and other camps of Utah. It was in those days that he became the trusted friend of Walker Bros., of Salt Lake City. In 1876, he visited Butte, Montana, in the interest of the above firm, and with them became part owner in the Alice Silver Mine of that camp. Up to this period in his life Marcus Daly exhibited nothing that promised to make him remarkable among men. He was a good, kindly dispositioned man, vigorous in manhood, faithful to his trusts, and esteemed highly by those who placed confidence in him. He soon became known in Butte, Montana, as a man of a most original and bold spirit in the management of a mine, and under his directorship the Alice silver mine proved a success. From this property he withdrew, selling his interest and prepared to get hold of some mine in which he would control the chief interest. He looked around to find such in, or near Butte, which was at that time an insignificant worked out placer camp, in which the Alice silver mine was the one conspicuous figure.

In those days there lived in Butte, two brothers named Michael and Edward Hickey. They were miners of quite limited experience, but ambitious and quite curious to possess a quartz mine, but as all likely ground was already located, they satisfied themselves with driving their stakes into a piece of ground that lay north of the town of Butte, or Silver Bow Creek, and on which they found some copper-stained float. Their locations were looked

upon as worthless by most of their associates, but a little work done on the Anaconda showed a large vein in which fairly good values in silver were associated with copper. These men had little means with which to develop this property, and upon being approached by Mr. Chas. X. Larabee of Deer Lodge, they gave that gentleman a one-third interest in the Anaconda claim to sink 35 feet upon it. This being done Marcus Daly came to look at it and offered to do further development upon it for an interest, which offer was accepted, and at 85 feet he offered \$30,000 for the claim. A deal was effected and Mr. Daly became owner of a mine that proved to be one of the greatest copper producers that the world has ever known.

We now come to the period in Mr. Daly's life when the latent greatness that was in the man developed itself, and from a man in the ordinary walks of mining life he developed into a giant, controlling, making, and directing all that moved in the mighty Anaconda property and still beyond, affecting every interest and industry that controlled in western Montana.

Besides the Anaconda, Mr. Daly soon owned the St. Lawrence and adjoining claims. Work was pushed forward on both the Anaconda and St. Lawrence, and as copper was then beginning to find a livelier market than ever before known, he took steps to establish works for the treatment of the ores of the mines he now owned. For this purpose he employed the highest talent of that day to find out the most economical methods of treatment for the product of his mines, and as a result purchased a large tract of land at the mouth of a canyon on the west side of Deer Lodge valley, some 17 miles from the mining camp of Butte. Under his own supervision, and of a magnitude that appalled his associates, he began the construction of works for the treatment of ores such as had not before been seen on the American continent, and carried them to completion. At the same time a city was laid out and named Anaconda. The new works for the treatment of copper ores proved successful and soon a stream of wealth poured forth in the form of copper matte and bullion such as few mines have ever produced. Those who in France and elsewhere had associated themselves with Mr. Daly were more than satisfied with the results of his managements and favors were heaped upon him such as few men in private life have ever received, while at the same time he himself became a millionaire by his labors that made many times millionaires of others.

About this time the railroad company on which Mr. Daly's company depended upon for the transportation of ores from the mines at Butte to the works at Anaconda having raised the freight rate to a ruinous figure, he built a road of his own which developed into a powerful local system. Over this road he ran eight trains each 24 hours, with twelve cars to a train and 24 tons to each car, or 2,204 tons each 24 hours; never less than this and usually more.

No wonder that millions of dollars accumulated to the credit of all who owned in this mighty property; and managing all of this intricate work was Marcus Daly, who year by year extended his influence over the resources of western Montana until his ownership rested upon mercantile institutions in Butte City, Anaconda, and elsewhere. The lumber trade of the same region became one of his possessions to a large extent. Almost an hundred miles away, in the wilds of Bitter Root Valley, on a tract of 20,000 acres of land, he reared a home that was the glory of the entire northwest. Here he placed in his stables the finest horses that the world could furnish, and cattle of the best blood were cultivated, whilst the home reared on the same area was as the house of royalty in finish and magnificence. In this beautiful country seat Mr. Daly gathered together all that a refined age and unlimited means could do to create an earthly paradise, and it was there that he would occasionally find a few days to enjoy surrounded by his friends and family. It was there that he hoped to pass the years of his old age. Mr. Daly had in his employ in mines and reduction works over which he held control and management, about 6,000 men, and he distributed a payroll that would suffice to meet the demands of a small national government.

He was a man of tireless energy, a man who sprang into prominence with the rise of a great mine, whose natural abilities were more than equal to the requirements of the tremendous work allotted to him.

Marcus Daly was a man of medium stature, stocky in figure, full chest, a strong manly and pronouncedly Celtic type of features, with strong gray eyes. He was intense in his likes and dislikes, like most men of his race. In politics, he backed his favorites with all his own strength, and never thought that he could go too far in serving a political friend. The life and profession of a miner he thought the noblest that man could follow, and he seemed proud to be classed as one of the great army of men who go down into the earth after the treasures that a beneficent Creator laid away for the use of mankind millions of years ago.

CRIPPLE CREEK.

Description of Volcanic Formation, and the Present Condition of the World's Greatest Gold Mining Camp.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The most striking feature to one visiting the region of Cripple Creek after an absence of some years is not merely the advanced development of the mines and the wonderfully pitted condition of the hills as though a sort of geological smallpox had broken out, but the dignified and substantial character which mining has there assumed.

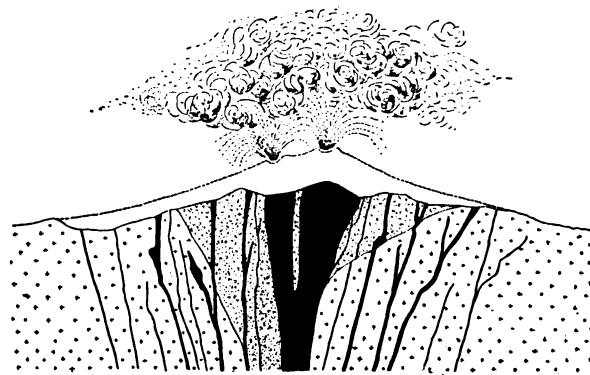
In early days we were interested in unraveling the complicated geology of the district. This, after the first brief period of prospecting, cleared the way for more systematic mining by a greater scientific knowledge of the country. This work was accomplished by the United States Geological Survey, and by individual researches, and although much doubtless remains yet to be known and while there are still many interesting problems to be cleared up, yet as we now glide over the hills in electric cars, where once we toiled on foot or on horseback, we feel as if we knew the geology fairly well.

The Cripple Creek Volcano.—Mr. T. A. Rickard, State Geologist of Colorado, gives in the transactions of American Institute of Mining Engineers an admirably comprehensive and clear, as well as popular description of the evolution of the ancient Cripple Creek volcano, in which the ores of Cripple Creek are now found. We propose giving a synopsis of this, occasionally taking the liberty of interpolating some few of our own observations on that district.

The Cripple Creek district occupies a cluster of foothills on the south side of Pike's Peak, and is a portion of an uneven plateau, uniting the eastern range of the Rockies with the Sangre de Cristo range. It is a small volcanic area of 20 square miles amid the granite of the Front range, and it is but an outlying portion of a much larger volcanic region stretching to the south and west around Silver Cliff and the Rosita Hills and north to the boundaries of South Park.

The mines are amid a volcanic complex of tuffs and breccia penetrated by dikes and intrusive masses. The prevailing formation is an andesite breccia, an adobe cement, formed of fragments of andesite lava, lying on the worn surface of the granite and filling deep basins around a volcanic vent. The breccia, since its deposition, has been broken into by several eruptions of phonolite and later by thin dikes of a species of basalt and other volcanic basic rocks. The eruptions probably occurred in early Tertiary time and long before the age of man.

The granite forming the basal rock is probably of later date than the Archean and of so-called Pre-Cambrian or Algonkian date. It is commonly marked by its large pink feldspar crystals. A later eruptive form of granite cutting through this is characterized by its fine grain, by its deep red color and by its "pegmatitic" character, i. e. being



IDEAL SECTION OF THE CRIPPLE CREEK VOLCANO.

composed almost wholly of quartz and feldspar with very little mica or hornblende.

The breccia may either be a cement or adobe of good sized fragments of andesite or a very fine admixture like a sandstone, in which latter case it is called "tuff." It is often kaolinized, i. e. the feldspars are almost reduced to a clay, and the dark minerals, hornblende or augite, have been leached of their iron components. The rock may present a white bleached appearance or be locally stained red or yellow by iron oxides. Fluorite is often present where the breccia is penetrated by gold-bearing veins and colors it a dark purple. Penetrating the breccia is an intricate series of dikes of phonolite lava, a light colored rock with sherd-like fractures composed of glassy orthoclase feldspar and nepheline. There are numerous other volcanic rocks represented by dikes, the most notable being the dark dikes of nepheline basalt associated with many of the ore bodies, and which appear to have been erupted last.

The Cripple Creek district represents the ground floor of a volcano from which the cone and upper parts have been removed by erosion.

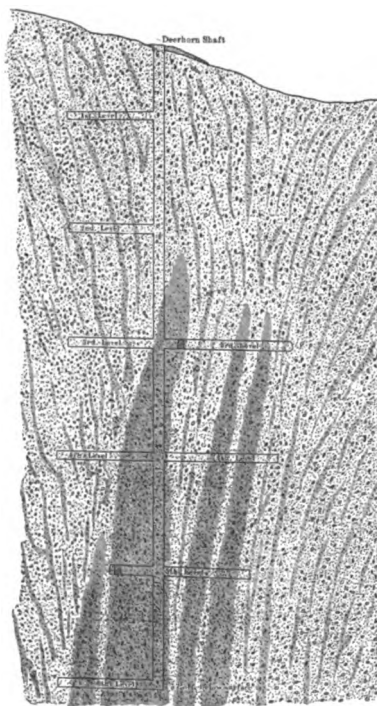
Mr. Rickard gives a popular sketch of volcanic phenomena generally, but with special reference to Cripple Creek, which is briefly as follows:

The explosive violence of volcanic eruptions is due in part, he thinks, to access of water to the fused rock within the conduit of the volcano, and in part to contraction caused by cooling of the earth's crust upon a yielding substratum, separating the solid outermost shell from an equally solid nucleus. The mass of molten rock which is being squeezed upward meets a large volume of

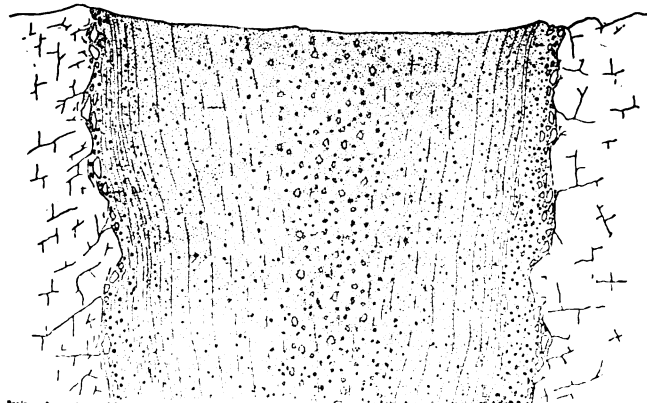
water which flashes into steam causing a violent explosion or eruption.

The volcanic rocks of Cripple Creek came up through granite. Previous to the eruption the granite presented a weather-worn appearance like that of the surrounding higher hills. This granite had long been in a slow state of uplift, culminating in the elevation of the Front range. It was the climax of this movement which brought on the volcanic action accompanied doubtless by severe earthquakes. These earthquakes were due to explosions of bodies of steam below, for a volcano in one sense may be called a safety-valve steam vent, the water producing the steam being derived from the surface.

The first vent was formed at some point along one of the fractures caused by the earthquakes. The pent-up steam burst through with a great explosion throwing fragments of rock torn from the vent. There were first fragments of granite, pieces of which are often found enclosed in the tuffs and breccias as well as in a stratified formation such as on Mt. Straub. The steam from a volcano condensing, forms terrific rain showers, which, collecting together the fine dust shot up in the air with that already fallen around the orifice of the volcano, descend the mountain in destructive mud-flows, deluging the valleys below. To such doubtless are attributable the bodies of consolidated breccia and tuff covering the region and filling up the ancient valleys in the granite.



AN EXTINGUISHED THERMAL SPRING, CRIPPLE CREEK.



VOLCANIC VENT IN GRANITE, AT VICTOR, CRIPPLE CREEK.

The exact location of the main vent is not as yet precisely known. A miniature vent, however, occurs near the town of Victor in the massive granite of Squaw Mountain near Battle Mt. It is filled with fragments of granite and pellets, nodules and rounded fragments of dark red andesite lava. At the edges rounded enclosures of this lava appear in the mass of fragmentary granite. In the center the lava forms a red granular matrix inclosing large pieces of granite. The material near the edges has a laminated structure parallel to the sides of the vent.

It will be observed that this vent is in granite as that of the original great eruption was. It is also filled with breccia as that was. The shattering of the sides suggests the mode of formation of the breccia. It only lacks the phonolite dikes to make it an exact counterpart of the greater Cripple Creek volcano.

After the first outburst a change took place in the matter ejected by the Cripple Creek volcano. Then began to appear the fragmentary andesite which was destined to be accumulated to such an enormous thickness. During long intervals of quiet, separating one period of eruption from another, the lava cooled, and cracked, and disintegrated by rain and frost was carried away by mountain streams to form the alluvium of the valleys. The superficial flows being thus removed exposed bodies of lava which had consolidated underground, such as the andesite rock on the eastern side of Battle Mt. near the Legal Tender mine.

The fragmentary eruption of andesite continued. The volcano must have been a splendid sight at night, its shifting lights being reflected on the snow-fields of Pikes Peak. These lights were due to the glow of the incandescent lava in the crater thrown upon the clouds of watery vapor hovering overhead. To this were added lightning flashes from electricity caused by the upward rush and friction of colliding particles of rock. There was the roar of the steam and the noise of the hurtling of the fragments of rock in mid air and of their fall on the mountain slopes.

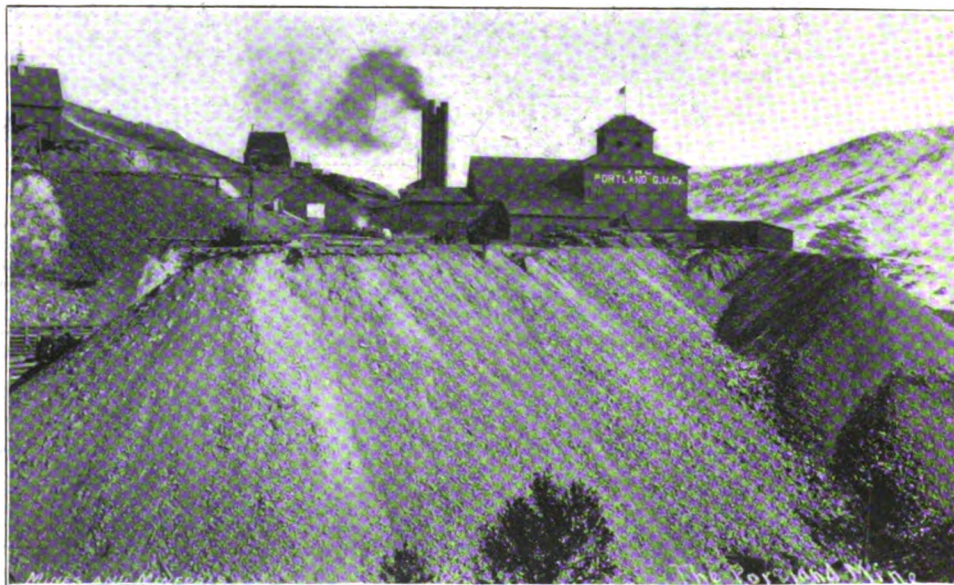
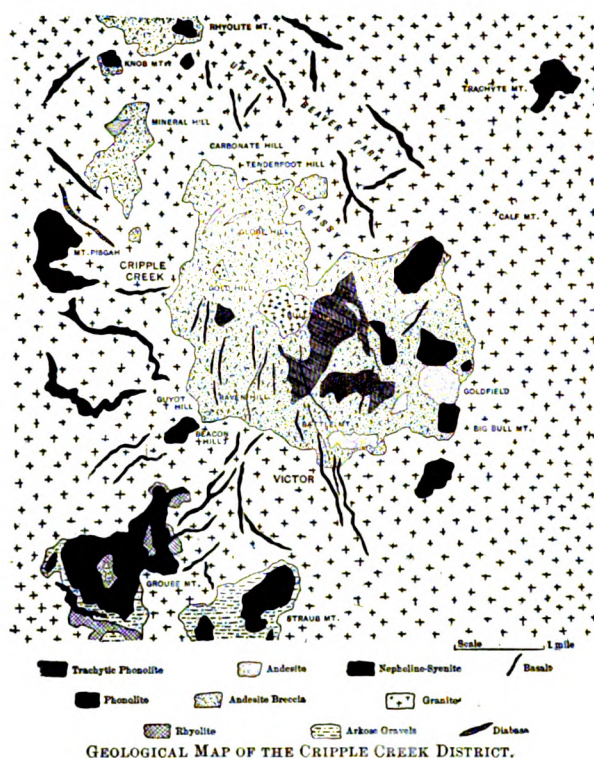
At this period similar outbursts were occurring among the neighboring hills and over distant regions. Over a large portion of Southern Colorado out of these eruptive products were sculptured the rugged peaks and ranges of the San Juan region.

After the eruption had continued long enough to form a vast accumulation of fragmentary materials which in time consolidated into an adobe breccia there was a period of quiet.

The Cripple Creek volcano must have formed a conspicuous and steep mountain as is commonly the case with volcanic cones built up of comminuted material from a highly explosive crater.

Projectile discharges were succeeded by great flows of massive lava as seen in the southeastern part of the district.

The period of quiet or inaction of the volcano may have



SURFACE PLANT AND DUMPS, PORTLAND MINE.

resulted in shifting the center of the eruption to another place along the line of fissure. The first conduit became plugged up by material which had failed of ejection. Other minor vents may have been formed on the flanks of the mountain which had been slowly formed by the long continuance of the discharge. When after an interval eruptions began again, these took place through a new vent or through fissures over congested masses of steam, due to water accumulated during the interval of inaction.

The Cripple Creek volcano had several vents. One near the site of Hull City placer, another near Anaconda. The original position of the orifice of an extinct volcano is inferred from the composition of the rocks. Lava cooling rapidly in the open air is glassy, containing few crystals, but that cooled slowly underground is a completely crystalline rock. So are distinguished surface lava-flows from that lava which cooled slowly below in the vent. The nepheline syenite of the Lillie and Vindicator mines is of this granular crystalline character, and hence probably filled one of the vents. So also the patch of syenite

porphyry between Gold Hill and Squaw Gulch. The steepness of the plane of contact between the granite and breccia on Guyot Hill suggests the probability of being on the edge of a vent.

The occurrence of several vents is not unusual, because volcanic eruptions occur along fissures giving rise to several large or minor eruptions and cones along that line of fracture.

Subterranean discharges forming intrusive sheets of lava are of much interest to the miner as he so often encounters these underground.

These may seek lines of weakness presented by the bedding planes of the strata, like the intrusive porphyry sheets of Leadville or they may take the laccolitic form and fill great cavities made by arching up of the rock as the Spanish Peaks or the laccolitic Elk Mountain range.

Dikes also seek out lines of least resistance. The successive periods of activity in the life of the Cripple Creek volcano are marked by the sequence of lavas extruded. This sequence is indicated by structural relations, the older extrusions being penetrated by the younger. The first was andesite, then came phonolite, and lastly nepheline basalt.

When the volcano had long been at rest the lava sank in its crater, causing subsidence and contraction which may have produced many of the fissured and large water-bearing cavities found in some of the mines. A period then set in of smothered activity characterized by geysers and hot springs and emanations of various gases, these leached rocks and brought mineral matters to or near the surface. Evidence of such hot-spring action is abundant. Breccias are bleached and decomposed, granite has its integral iron compounds dissolved, the rock reduced to a

cavernous or incoherent mass, and secondary minerals introduced. At the Deerhorn Mine are direct evidences of a hot spring. At 420 feet depth a body of gypsum is encountered and below that abundant evidences of ancient hot springs in decomposed rock and kaoline and fluorite stains.

Sulphuretted hydrogen and sulphurous acid gases were emitted together with hydrofluoric acid, producing large amounts of purple fluorite or fluoride of calcium, especially in the gold bearing bodies. This gas had a powerful effect in decomposing the rocks and seems also to have been intimately connected with the deposition of gold-bearing ores, as it is frequently found closely associated with them. It even dissolved or attacked the quartz in the ore-bearing granite of the Independence mine.

This solfataric period of long duration was of great importance to the mining geology of the region. It helped to solidify the breccia and tuff. The cooling of intrusive bodies of lava causing contraction developed lines of weakness along which the energies of the volcanic center developed fractures permitting the prolonged circulation of underground waters carrying mineral in solution. These heated waters ascended through these fissures to the surface and dissolving out the metals from the deep-seated rocks brought them near to the surface, where release of pressure and lowering of temperature forced them to precipitate their contents. Finally all volcanic signs of activity ceased and the country breccias as we find it today. A striking feature, as we have said, is the extraordinary pitting of the hills with prospect holes and other excavations. No district of equal size, we believe in the world, is so full of prospect holes or so crowded with mining plants. This is partly due to the intrinsic value of the small area, and the fact that so few signs show on the surface, that everything must be explored beneath it.

A more impressive feature is the size and importance to which many of the old time mines have grown, shown by the large and substantial edifices or plants over them and by the vast size of their dumps intersected by numerous railroad tracks of various kinds and descriptions.

The whole mountain back of the town of Victor is a mass of nearly continuous dumps of different mines lapping one on the other. These dumps are from 50 to 100 feet high and it is becoming a serious question what in future to do with dumping material. In some instances we see railroads passing by steel arched tunnels underneath great dumps, in others going over them. Dumps are being cribbed and confined and propped up in

all sorts of ingenious ways. But a time will come, especially for those mines like the Gold Coin right in the heart of a town, when there will be no more room around the mine, and a railroad will have to carry the dumpage beyond the city limits to fill up some worthless ravine or, to build up some necessary road, or to enlarge ground for building purposes.

Surmounting these great dumps are lofty mining plants containing machinery of the newest and largest patterns, where formerly there were only wooden shacks and a gallows frame, or a horse went his monotonous round in the open air working a Davis whim.

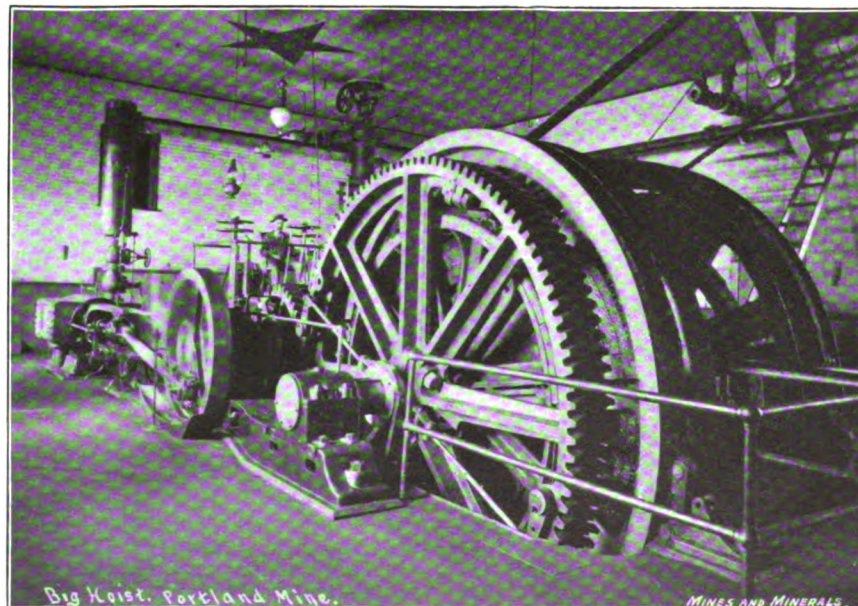
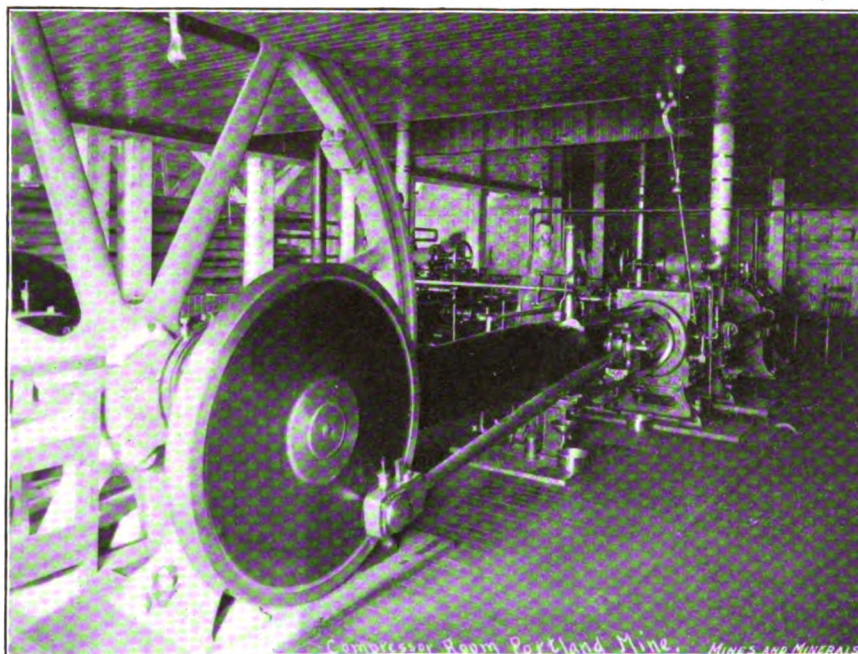
We remember when the first shaft house of the Independence mine was erected, we considered it an innovation on Colorado mining, and coming once to Victor in the dark we mistook the building for a large new hotel. This plant with its double compartment hoist and electrical appliances was the pride of the place, but since then either from rivalry or necessity, it has been surpassed by many others. And when old plants by fire or other accident have been demolished, the fashion at present is to exceed all former ones in the size and equipment of the new works, such as are seen in the Gold Coin, Strong, Portland and others.

Taking a short ramble amongst some of the plants of the larger mines in the vicinity of Victor, we climb the hill past big dumps, storehouses and offices to the Portland mine and enter its spacious building, which is shown in the accompanying illustration.

Here is a double compartment shaft 1,000 feet deep. Near it the gallows frame 60 feet high and a big double reel 18 feet in diameter carrying a flat rope 2,000 feet long and 6½ inches wide. The reels have the usual friction clutch and brake on the outside. The engine controlling this has a 22 inch × 36 inch cylinder. The engine room is of two compartments separated by arches and pillars. It is the pride of the mine, and contains some of the finest air compressors in the

West. There are two sets of these machines, one small and the other large. A view of the air compressors and hoisting engines is shown in the accompanying photograph. No. 1, the smaller, is an Ingersoll compressor with capacity of 20 drills. The engine is a simple Corliss engine with the fly wheel 18 feet diameter. The two-stage compressor has a capacity of 45 cubic feet of free air for each revolution.

No. 2, has an air cylinder 18 inches in diameter, steam cylinders 19½ inches × 48 inches. Fly wheel is 20 feet in diameter and 4 feet wide across the rim. There is an upright intermediate



MACHINERY AT PORTLAND MINE.

receiver and cooling cylinder. The machine is about 40 feet long and has a capacity of 30 drills. Both engines are condensing, the condenser being below the floor of the engine room.

The dynamos are 115 volts, 350 amperes, and they are run by an Ames 80-H. P. high speed steam engine.

There are ten 80-H. P. tubular boilers, and three Snow pumps are used to raise 1,200 gallons of water per minute from a depth of 700 feet.

From this plant we walked down to the Strong Mine close below the Independence. Here is an extensive new plant in process of construction superseding the older structure and doubling everything. A fine hoister with a flat cable was in position, a flat cable used with a reel being preferred to a round cable with a drum, as a drum takes up more room.

The reel is 11 feet diameter, and the flat rope is 4 inches wide by $\frac{3}{8}$ " thick. The Webster clutch and brake are set with steam. The capacity of the hoisting plant is a 5 ton load hoisted 2,500 feet. The depth of the mine at present is 825 feet. The stroke of the engine is 48 inches.

The gallows frame is 60 feet high in the clear, the posts are 16 inches $\times$ 16 inches, and the shaft has 3 compartments. There are four boilers of 40, 60, 80, and 100 horsepower, respectively. Two small compressors, are at present in use for the Leyner drills. Two large 260 horsepower tubular boilers of Babcock and Wilcox make were in process of erection at the time of our visit. These tubular boilers are at present the latest fashion at Cripple Creek.

A marked feature of the more recent plants is the care shown for the comfort of the men, and at the Strong mine there is a large comfortable and well equipped dining room for the use of the men. This is the mine that in the early days was blown up by the strikers and in which Macdonald and others were imprisoned. The geological conditions of the vein and ore body are not unlike those of the Independence being in phonolite and granite, carrying telluride ores.

From the Strong Mine it is but a little way to the new works of the Gold Coin Mine now going up. The Gold Coin plant, it will be remembered, with all its elaborate equipment was burnt to the ground in the fire which destroyed the town of Victor in 1899. This fire, after demolishing the plant house, descended several hundred feet down the shaft and did considerable damage. From the ashes a far finer plant is in process of erection of which we will give a description in another article. The plant is being erected right in the town of Victor near the site of the old hotel, and it will be recalled that in digging the foundation of this hotel the peculiar and unpromising looking "shear-zone" vein of the Gold Coin mine was discovered which led with depth to the present great vein.

Another marked feature in the development of the camp is the system of long crosscut tunnels undermining the district. There is the Chicago tunnel in Poverty Gulch; the Standard tunnel starting from Beacon Hill on the west aiming to go right through the district to near the Victor mine on the east; the Moffat tunnel, and the Gold Hill tunnel running under Globe Hill to unwater and transport from the Moon Anchor and other tributary mines. There is also the United Mines tunnel, which from the Gold Coin Mine shaft at Victor goes clear through the granite of Squaw Mountain to the Economic Mill on the other side in Arequa Gulch. These are also crosscut tunnels whose main object is the unwatering of mines and transportation of ores with possibilities of intersecting blind and hitherto undiscovered leads at great depth.

Some of these tunnels have encountered considerable bodies of water, a feature very welcome and very different from the conditions in the early days of Cripple Creek, when both the mines and the whole district were proverbially dry and lacking in water, even in the creeks and streams. The largest bodies struck in those days were in the Prince Albert and Blue Bell mines, from the latter came a stream sufficiently large to run a big concentrating mill in the gulch.

Now both deep tunnels and mines have struck water commonly sufficient for local machinery and sometimes for local milling purposes and sufficient in some cases to need the use of very powerful pumps to keep it under proper control. The progress of the Standard tunnel has for some time been arrested owing to the rush of water at certain seasons of the year, amounting to 20,000 gallons per minute.

But perhaps the most noticeable of all the features in the camp is the comparatively recent application of electricity for mining and transportation purposes. Nearly every mine of any size has its electric hoist and its works are lighted by electricity. In going into a mine plant you quite as much expect to see the dynamos as in former days you did the ordinary hoist or the Davis horse whim. Electric wires and posts run all over the hills all the way down to Cañon City, where is one of the principal power plants. Distributing electric stations are encountered at various

high points on the hills. The peculiar frame work indicating an electric hoist in the mine below crops up everywhere, at mines both small and great, and you pass through tunnels well lighted by the same mysterious fluid. Electric motors for hauling cars through long tunnels are having everything prepared for them, and through these formerly dark abodes below the hills we shall soon ride along in trolley cars with all well illumined around us.

There is but little of an old fashioned character left in Cripple Creek, it is an up to date camp, and is keeping on the topmost rung of the ladder of progress. The latest innovation and the newest power of machinery is at once put in force with wonderful speed and adaptivity.

The wealth of a mine is not hoarded in a bank but is put out to improve and push ahead. This is the true spirit of Cripple Creek as seen in the Gold Coin and the other operations of the Woods Company, and in the Independence, Portland and others. The use of electricity as a motive power is forcibly shown in the electric railroads traversing the hills from bottom to top and all around and making access to every important mine easy and pleasant.

Formerly we well remember toiling over the Cripple Creek hills on foot or on horse back. Every step in Cripple Creek was then a necessary climb. Now electric cars carry us in comfort to any mine we want to see, we stop anywhere, make our examination, and go on again. Miners have their homes in the town and go and return daily from their work in these electric cars, or on steam cars, for there is as much of the one as of the other. The lively little camp is a network of railroads and car lines of all kinds and descriptions like the streets or environs of a great city.

Still another feature is the milling facilities. In early days the surface oxidized ores were found to be for the most part free milling, consequently ordinary stamp mills and concentration works abounded, but soon it was found as depth was attained that these ores passed into unoxidized tellurides and sulphide ores, and that the former simple processes would not save the values. Ores had to be shipped far away to Denver and Pueblo to be smelted. Various schemes and processes were tried for mills on the spot, the two proving most successful were the cyanide and chlorination processes. Two or three medium sized mills of this kind were established, but the general absence of sufficient water and the total absence of coal at Cripple Creek caused the progenitors of these processes to make Florence on the Arkansas River the seat of their future works and of their largest mills, where water, coal and railroad transportation could be easily obtained. So Florence has become the Swansea of Cripple Creek. Here were established the Davis chlorination mills, and here Mr. Argall located his noted cyanide works, the largest and best equipped in the West. Lately Mr. Milliken who had successfully tried chlorination on a small scale at his mill at Cripple Creek is building one of the largest chlorination mills of the West equipped with the largest and newest appliances. Not far from here on the same bank of the Arkansas the Dorcas Company is constructing another large cyanide mill and a pyritic smelter is also under way. Florence has become the center for the chemical or liquid treatment of ores, especially those of Cripple Creek, as Pueblo has long been for the smelting or treating of ores by fire, from all parts of Colorado.

But though Cripple Creek itself is not generally well adapted for milling purposes it is not left destitute of mills. Besides the original small cyanide and chlorination mills the Woods Company, having exceptionally good local advantages for the purpose, has built a very large chlorination mill in Arequa Gulch which is doing excellent work with the ores of the Gold Coin and other Cripple Creek mines. Of this we give a description in another article.

From the top of any hill or from the windows of the electric cars traversing the hill tops there is the constant spectacle of smoking stacks of mines and mills and locomotives. The spirit of life, activity and progress seems to pervade the whole community and is felt like an electric shock directly we set foot in this, the liveliest camp in Western America.

Finally we must notice the progress the towns of the region have made. From a few log cabins the town of Cripple Creek rapidly grew to a fair sized mining town, but with too many of the old time shacks to make it safe from fire. Accordingly the purifying fire which seems inevitable to the first decades of a mining town, visited in turn both Cripple Creek and Victor. The result is that now two first class towns have risen from the ashes without comparison to their former condition. In addition to this some half a dozen very respectable sized burghs have grown up in the vicinity.

Another element is worthy of the highest notice. Cripple Creek was long notorious for its gambling. Some men were even short sighted enough to maintain that the worldly business prosperity of the place could not succeed without the maintenance of the gambling element. A new Mayor was elected, a

man of unswerving integrity and courage, and gambling is being suppressed as contrary to the laws of the United States; and lo! as the darkness fades before the light the town is becoming more prosperous than ever.

To drive out evil the best way is to plant good, the pressure and presence of a number of good citizens has driven much of the low and evil sort into the shade. We have already alluded to the good work of the Gold Coin in planting a handsome club room and reading room in the heart of Victor, a description of which will be given in the next number of MINES AND MINERALS.

With other improvements and elements of progress that of the monetary business kind has been equally remarkable. Statistics which we believe can be relied upon are as follows: Starting with a production of less than \$200,000, in 1891, in 1899 the gross production was over \$20,000,000, in gold. Dividends have been paid up to the present date exceeding fifteen millions.

The average values of the ores mined in the district is between \$30 and \$40 per ton. Of course there have been a great many shipments sent out of ore of such phenomenal richness as to make the results appear almost incredible. Cripple Creek is maintaining its record. The average monthly output from the mines has exceeded two millions. \$30,000,000 is anticipated for 1900.

There is little question as to the permanency of the camp from the fact that the deepest workings disclose the largest and richest ore bodies. The three foot veins of 100 feet depth have become in several instances with depth 20 to 50 foot veins. Again from a comparatively small area supposed to be the only mineral bearing zone, the producing area has expanded in all directions from Lawrence on the south to Copper Mountain on the north, and from Mineral Hill on the west as far east as the base of Pike's Peak.

Iron Ores of Georgia.

This State supplied 236,748 long tons of iron ore in the year 1899. Of this amount 179,748 tons, or 75.9 per cent., was brown hematite and 57,000 tons, or 24.1 per cent., red hematite, giving it fifth and sixth place in these classes of ore. The production shows an increase of 76,665 long tons, or 47.9 per cent., over the 160,083 tons mined in 1898, when Georgia and North Carolina were reported together.

In the summer of 1899 Mr. S. W. McCallie, Assistant State Geologist, made an examination of the brown hematite ores of Georgia, which are found mainly in the northwestern part of the State, in what is known as the Paleozoic area. He reports that the ores occur chiefly in the Lower Silurian formation, but are also found associated with the Carboniferous and the Cambrian deposits. The most abundant iron deposits of the Lower Silurian are in the Knox dolomite series. This magnesian formation often contains an abundance of chert, and usually gives rise to low, well-rounded ridges, along which the iron-ore deposits occur. The ore is found in pockets or irregular deposits in the residual clays that have resulted from the weathering of the magnesian limestones. In connection with these ores more or less chert and manganese are frequently found. The extent of the deposits is variable, in some cases only a few tons being obtained, while in others several thousand carloads have been won. Where the ore was found in large quantities the former method of mining was by means of shovel, pick, and screen, but at present these have been superseded by steam shovels and log washers, greatly reducing the cost. The screen method of working the ores is still adopted where the banks are small or unfavorably located for obtaining water for washing. This method is wasteful, however, the fine-grained ore being left on the dumps, and some of these old dumps are now profitably reworked by means of the log washer.

The ore is generally won in open cuts varying from 5 to 60 feet in depth, or to water level. The extent of the ore bodies varies greatly in depth in different localities. At Oredell a bore hole showed the ore to extend to a depth of more than 175 feet, while valuable deposits near Cedartown have been worked to a depth of 70 feet without apparent decrease in richness. The ore deposit is often interrupted by huge masses of white or vari-colored clay "horses."

The locations of the ore deposits are as a rule indicated by the occurrence of more or less float on the surface; but the abundance of the float ore is not always a criterion of the quantity of ore beneath, as one of the best deposits in the vicinity of Cedartown had a remarkably poor surface prospect.

The ores of the Knox dolomite series show 48.45 to 51.10 per cent. metallic iron, from 0.20 to 5.60 per cent. manganese, from 2.40 to 7.87 per cent. silica, and from 0.147 to 0.58 per cent. phosphorus.

The iron ores of the Cambrian formation occur associated with sandstone, mica shists, and slates. They have been worked extensively in Bartow County, where they occur in the vicinity of what is known as the Cartersville fault, which is the line of demarcation between the crystalline and Paleozoic areas. The

Cambrian brown ores differ somewhat in their character and mode of occurrence from those of the Knox dolomite series. In some cases these ores have been metamorphosed, and in a few instances partake of the nature of a true hematite. The ore deposits near Emerson often assume the character of true veins, and vary in thickness from a few feet to several rods. At the Wheeler mine the ore is variable in thickness, and has been worked along the outcroppings for nearly one-fourth of a mile, and to a depth, in places, of 40 feet or more.

In the northern part of Bartow County, in the Sugar Hill district, the ores partake of the nature of a blanket deposit, and are found principally in the residual clays and partially decomposed slates overlying the sandstone. These blanket deposits are valuable on account of their richness and the cheapness with which they can be mined. In other localities in the neighborhood of Buford the ores occur in pockets and irregular deposits, as in the Knox dolomite series.

The Cambrian ores are always free from cherty material, but this impurity is frequently replaced by siliceous material in the form of sandstone, which renders the chemical analyses of the Knox dolomite and the Cambrian ores very similar in character.

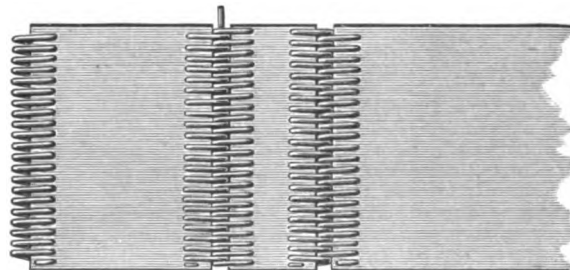
The Carboniferous ores occur chiefly in the lower division of this formation, associated with the Fort Payne chert. These deposits have been more or less extensively worked along the eastern foothills of the Horn Mountain, in Sugar Valley. They are also reported to occur upon the western side of Big Texas Valley. These deposits are apparently not so extensive or valuable as the Knox dolomite or Cambrian deposits, nevertheless are of considerable economic importance.

Besides the brown ore deposits of the Paleozoic area, there are also to be found in the crystalline area along the Atlanta, Knoxville and Northern Railroad valuable deposits of brown ores, which are practically undeveloped. The more extensive mining operations are confined mainly to Polk and Bartow counties.—*U. S. Geological Survey Report.*

Jackson Belt-Lacing Machine.

This device for lacing belting is so well known that it need not be described in detail, but the results of some recent tests made upon belts laced with this machine are of considerable interest. One belt broke under a strain of 3,420 pounds without the lacing giving away. Another belt which was laced extra heavy with ordinary raw-hide lacing to prevent the lacing breaking, broke under a pull of 1,490 pounds, along the line of the outer holes of the raw-hide lacing. The same belt laced on the Jackson Belt-Lacing Machine, and using twine to connect the lacing, broke under a pull of 1,850 pounds by the lacing pulling apart, but without further injuring the belt. These tests were made from small pieces cut from the same piece of leather.

We have also recently seen a belt laced on one of these machines which had been running almost constantly upon a milling machine for four years and a half. This belt, after this time, gave out through the wearing out of the lacing caused by rubbing on the steel pin used to connect the two pieces of the belt. A number of different pins are used to connect the two parts of the lacing, viz., steel, twine, raw-hide, etc.



The well known advantages claimed for this form of belting are the quickness with which the lacing can be done, the cheapness of the process, it being claimed that the cost of lacing is only one-tenth that of other processes; the belt can be connected or disconnected in a moment, which is a great convenience where belts of various lengths are required for work where it is desirable to have a reserve belt in readiness. It is also a most convenient method for holding together old or worn out belts.

The Jackson machines vary in price from \$65.00 for a 6-inch machine to \$125.00 for a 24-inch machine, and with each machine 6,000 inches of coiled lacing is furnished, which, it is claimed, is equal in value to about \$80.00 worth of lacing leather.

Full particulars and details of this machine can be obtained from the Diamond Drill & Machine Company, the manufacturers and owners of the patents, whose works are at Birdsboro, Pa.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Hoisting Engineers' Examination, Held at Centerville, Iowa, September, 17, 1900.

QUES. 1.—What are the duties of a hoisting engineer?

ANS.—(1) To remain diligently at his post during the hours when he is supposed to have charge of the engine, and not to absent himself until relieved by another engineer or responsible party. (2) To acquaint himself thoroughly with the code of signals in use, which he should keep posted in the engine room. (3) To respond promptly to all intelligent signals, and to maintain complete control of his engine when running the same; exercising special care and caution when hoisting or lowering men. (4) To clean and oil his engine regularly and to keep the same in good repair, giving special attention to brakes, drums, ropes, etc., to maintain these in a safe condition and in running order. (5) If an indicator is used in the engine room to denote the position of the cage or trip at any moment, a complete reliance should not be placed upon this, but the engineer should maintain such marks upon his hoisting rope as to enable him to know beyond a doubt, of the near approach of the cage or trip to the upper or lower landing. (6) To possess a thorough knowledge of, and acquaintance with all the working parts of his engine.

QUES. 2.—What are the qualities and qualifications that should characterize a safe and reliable engineer?

ANS.—He should be (1) sober and temperate in his habits; (2) Faithful and observing while upon duty; (3) Clear headed, prompt, cool, and deliberate in his action.

The necessary qualifications of a safe and reliable engineer may be stated as follows: He should possess (1) A thorough knowledge and acquaintance with his engine as regards its power and speed; (2) A technical knowledge of steam, boiler pressure, cylinder pressure, loss of power in condensation; what is meant by dry steam, wet steam, saturated steam; advantage of early cut-off, and work of expansion, &c. (3) A knowledge of different types of engines as simple or compound, duplex or triplex, and the advantages and adaptation of each type; (4) A certain amount of practical knowledge and skill in the handling of the throttle and brake levers, as well as in the repairing of parts of his engine.

QUES. 3.—What is meant by the term "horsepower"?

ANS.—The power required to raise a weight of 33,000 pounds through a vertical height of one foot, in one minute of time.

QUES. 4.—How is the horsepower of an engine determined?

ANS.—The horsepower of a simple engine is usually calculated by estimating the power developed in one cylinder only, whether the engine is single or double. The usual formula used for this purpose is as follows:

Let H = the horsepower developed,
 p = the mean effective cylinder pressure (lb. per sq. in.),
 l = length of stroke (ft.),
 a = the sectional area of the steam cylinder or piston (sq. in.),
 n = number of strokes per minute.

Then,
$$H = \frac{p \cdot l \cdot a \cdot n}{33,000}$$

By substituting the given values in this formula the horsepower of the engine is obtained. For example, let it be required to find the horsepower of a $10'' \times 16''$ duplex hoisting engine having a mean effective cylinder pressure of 50 pounds per square inch, and making 150 revolutions per minute, or $150 \times 2 = 300$ strokes per minute. These given values are substituted in the above formula, thus,

$$H = \frac{p \cdot l \cdot a \cdot n}{33,000} = \frac{50 \times \frac{1}{2} \times (.7854 \times 10^2) \times 300}{33,000} = 47.6 \text{ h. p.}$$

QUES. 5.—What is there in water that produces incrustation? The causes of incrustation are given in the Coal and Metal Miner's Pocket Book (6th Edition) as follows:

1. Deposition of suspended matter.
2. Deposition of salts from concentration.

3. Deposition of carbonates of lime and magnesia, by boiling off carbonic acid, which holds them in solution.

4. Deposition of sulphates of lime, because sulphate of lime is soluble in cold water, less soluble in hot water, insoluble above 270°F .

5. Deposit of magnesia, because magnesium salts decompose at high temperatures.

6. Deposition of lime soap, iron soap, etc., formed by saponification of grease.

QUES. 6.—What kind of incrustation does most harm, and in what manner may it tend to produce an explosion?

ANS.—All manner of incrustations in boilers are harmful, and should be prevented as far as possible or removed as they form. Some incrustations are harder than others, and more difficult to detach from the boiler shell. These perhaps are the more dangerous class of incrustations, because they allow the plates to become very much overheated and perhaps ruined. The manner in which incrustations act to produce explosion is as follows: The incrustation not being a good conductor of heat destroys the efficiency of the boiler, or its capacity to produce steam. To overcome this defect the fire is urged too strongly, and the parts of the boiler exposed to the fire become very much overheated and bulge or blister. The plates expand quicker than the incrustation lining them, which may result in cracking the incrustation, thus suddenly permitting the water to come in contact with the red hot plate, resulting in the sudden formation of a large amount of steam, and an explosion is the result.

QUES. 7.—What is the difference between priming and foaming in a boiler and what causes it?

ANS.—What is known as priming, in a boiler, is very different from foaming. Foaming is the bubbling of water caused by the steam as it escapes to the surface. When the boiler primes the water is carried over with the steam into the cylinder of the engine where it is liable to do much damage. Foaming of the water in the boiler may or may not result in priming. Priming may result from a number of causes, but is often due to imperfect construction of the boiler, or to a faulty manner of taking the steam from the boiler, or to carrying too many gauges of water while running. Foaming is usually the result of the presence of grease or other impurities, in the water, which render the escape of the steam up through the water more difficult, the water being lifted by the steam bubbles as they rise. Whatever tends to form a scum upon the surface of the water, or to render the molecules of water more cohesive will tend to produce foaming in the boiler.

QUES. 8.—What is the object of a feed water heater?

ANS.—The first and perhaps principal object is to economize fuel by saving heat; the feed water being heated usually from the exhaust steam of the engine and entering the boiler at a temperature very close to its boiling point. Another important object sometimes attained is the purification of the feed water.

[Water holding in solution a considerable amount of carbonate of lime owing to the presence of carbonic acid gas in the water, is purified very largely in passing through the heater previous to entering the boiler, the carbonic acid gas being expelled by the heating and the lime precipitated. Waters containing sulphate of lime, which is soluble in cold water, are purified to a considerable extent in the heater, since the sulphate of lime becomes partially insoluble when the water is heated; but in such cases the temperature of the heater must be greatly increased by the use of live steam for this purpose.]

QUES. 9.—How many gauges of water would you consider it safe to leave in a boiler after banking the fire?

ANS.—When banking the fire under the boiler for the night, or for any length of time, it is usually advisable to leave the boiler well filled, or, say to have 2½ or 3 gauges. [By doing this there will be no danger of the water running low before morning should the fire start up somewhat, and there will be a good body of hot water for a start in the morning.]

QUES. 10.—What are the chief points in the construction of a good, economical boiler?

ANS.—(1) The boiler should be of sufficient strength to resist the pressure it is designed to carry. The boiler pressure will vary in mining practice, according to the class of work, from 60 pounds to 100 pounds, or 120 pounds per square inch. The strength of the boiler is very largely affected by the form of joint and style of riveting adopted; by the position and number of its stay rods, and in tubular boilers by the number and position of the tubes and manner of calking the same; by the thickness of the shell or boiler plate. (2) The heating surface of the boiler should be sufficient for the generation of the required quantity of steam. The volume of the steam space above the water in the boiler should be sufficient to avert the danger of the water being carried over with the steam into the cylinders, or the danger of priming. (3) The area of the grate should be proportional to the heating surface according to the type of boiler and kind of draft employed. (4) The setting of a boiler is an important point aside from its construction. The

boiler should be set so as to allow for its expansion and contraction, in order that the brick work and masonry may not be injured from this cause. The boiler should be set with a slight drainage toward the mud drum or blow-off at the rear end of the boiler. If this is not done the accumulation of sediment over the portion of the shell immediately exposed to the fire will cause trouble and be a constant source of danger. (5) The boiler should be provided with an efficient safety valve, and gauge cocks, in addition to a glass water gauge. The feed water should be introduced into the boiler preferably at a point a little below the water line in the boiler, and steam should be taken from the boiler at a point in the dome where there will be less danger of priming taking place. (6) Maximum durability, and minimum liability to need of repairs. (7) Easy accessibility of all parts of the boiler, internal and external for repairs and for removal of scale, mud, dust and soot.

QUES. 11.—What parts of stationary engines should receive particular attention at the beginning of each shift?

Ans.—Particular attention should be given when starting an engine that has been idle for a period of time, to see that all of its bearings are in proper adjustment and cleaned and lubricated. The oil cups at the various joints and bearings should be supplied with oil. It is important in starting an engine to see that the drain cocks of the cylinders are open, and the cylinder free from any accumulation of water that may have drained from the steam pipes or formed from the condensing of the steam in the cylinder. [If this is not done serious damage to the engine may arise. The cylinder head may be forced off, or the piston broken from its stem, by the water, which may more than fill the clearance space and which is practically incompressible. This will produce a severe shock to the moving parts of the engine.]

QUES. 12.—In making an examination of a cylinder boiler, to what parts would you give special attention?

Ans.—Special attention should be given to those parts of the boiler where the plates are exposed to the immediate action of the fire, especially where the tubes are calked, or join the boiler ends. Care should be taken to examine all the riveted joints of the boiler, especially those points where stay rods are made fast to the boiler plates or shell. The various connections and boiler fittings should be likewise examined carefully. Throughout the examination particular attention should be given to the corrosion of stay rods, rivets, or plates, which would tend to weaken the boiler.

QUES. 13.—What are the advantages of a double over a single hoisting engine?

Ans.—A double hoisting engine is so arranged that its cranks are at right-angles to each other. This arrangement gives the double hoisting engine the advantage over a single engine, that it can never be stopped on dead center. The engine is readily started at any point of its stroke, since one or both of its cranks is always off center, the engineer also has a better control of the cage, and there is less danger in the hoisting and lowering of men. In the handling of heavy loads the double engine will start more readily than the single, and does not require to be started as suddenly in order to pass center, as is the case in a single engine.

QUES. 14.—What causes expansion? In what direction is it greatest? Give reasons for your answer.

Ans.—This question probably refers to the expansion of rods, rivets, nuts or boiler plates. Expansion is usually the direct result of the application of heat. Pressure or tension may expand a body, but this is not properly called expansion but extension. When heat is applied to a body the temperature of the body is raised, and its molecules are thrown into more rapid and extended vibrations. This causes the molecules to separate farther from each other, which results in the expansion of the body. Cubical expansion of a body takes place in all directions alike, but the resulting extension is greatest in the direction of the greatest dimension. The lineal expansion of a boiler or of a rod is more apparent, therefore, than the expansion in its cross-section, or the enlargement of its volume.

QUES. 15.—Is a gauge cock or a water glass to be preferred? Why?

Ans.—The gauge cock is always more reliable upon a boiler than a water glass; and if but one of these is to be employed, the preference should always be given to the gauge cock. The water glass is convenient, but not at all reliable, and many engineers prefer that it should not be placed on the boiler on account of its often deceptive indications. The reason for this is that the tubes leading from the boiler at either end of the water glass may, and often do become entirely stopped, which results at once in the water becoming stationary in the glass, and not indicating the true level of the water in the boiler; or no water may appear in the glass, when there are several gauges in the boiler. In this event the engineer is absolutely deceived by the indications of the water glass, since he has no means of knowing its condition. This is not the case where gauge cocks, or try cocks as they are often

called, are used to indicate the height of water in the boiler. If one of these cocks becomes clogged it is known at once to the engineer, since either steam or water must always issue when the cock is turned. The cock is then cleaned out by inserting a suitable wire.

QUES. 16.—What are the different kinds of safety valves? Explain each.

Ans.—The forms of safety valves in most common use are the lever valve, the spring balance valve, and the dead weight valve. The latter is seldom used. The lever valve as shown in Fig. 1, consists of an ordinary lever *L* suspended above the valve *V*, and bearing upon the valve stem *P* in such a manner as to press the valve upon its seat with a certain force. The force with which the valve is retained upon its seat is increased or decreased by moving a weight *W* out or in along the length of the lever. In the spring balance safety valve the valve is pressed upon its seat by the action of a spring held in position by a stem, nuts above regulating the force of the spring. The form of safety valve known as the dead weight

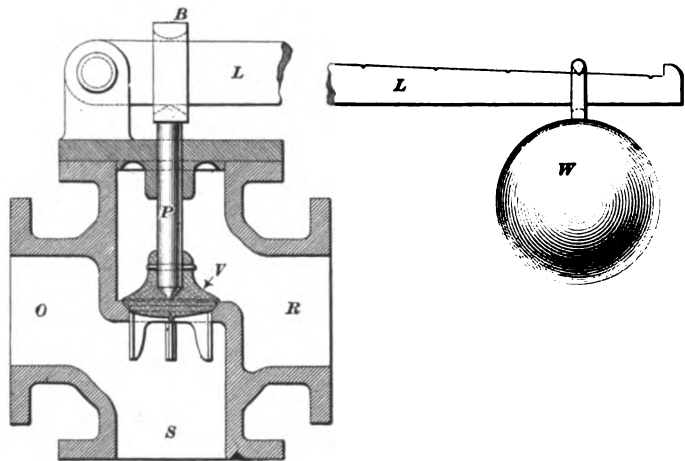


FIG. 1.

valve is no longer used. There are two styles consisting of a heavy weight mounted over or under the valve and holding it upon its seat.

QUES. 17.—What, in your opinion, is the best kind of boiler for use at a coal mine? Why?

Ans.—Until comparatively recently the form of boiler in most common use in connection with coal mining was the ordinary cylindrical boiler or one of the Lancashire type. These forms of boiler seemed best adapted for use at a coal mine, for the reason that they were simple in construction, easily cleaned, and repaired at small expense, while the item of a saving in fuel was not considered essential.

This practice is rapidly changing however, and modern tubular boilers are replacing the older types in many sections of the country as they are much more economical of fuel.

QUES. 18.—If after you have set the valve and keyed everything properly there is still a knock in the engine, how would you locate it?

Ans.—This is a difficult question to answer satisfactorily, inasmuch as a knock of this sort, in an engine, is often an extremely difficult thing to locate. We have known engines to run for a great length of time with such a knock, and experienced engineers have failed to ascertain the cause of the same. The knock in an engine is often found to arise from a loose crank pin, wrist pin, or cross-head. It may occur from the looseness of the piston or follower upon the piston rod, and in this case would prove a serious matter. A click sometimes occurs in the cylinder of an engine, due to the steam pressure gaining access to the packing rings of the piston, causing the ends of the ring to strike together and produce a clicking sound. A knock is sometimes produced by the striking of a key or wedge that has been driven up too far. There are numerous other causes which may occur to produce this trouble, but these can only be ascertained by extreme diligence, care, and skill on the part of the engineer.

QUES. 19.—In setting a steam boiler what is the result if the proper allowance is not made for contraction and expansion?

Ans.—The tearing apart of the setting of the boiler, or the rupture of its hangings or supports, probably followed by the settlement of the boiler out of position, bringing an undue strain upon the boiler itself, and possibly causing the joints between the plates to part, and leakage of steam or water or both to ensue.

QUES. 20.—What, in your opinion, is the best place to connect a feed pipe to the boiler? Why?

Ans.—There is some difference of opinion in regard to the

proper place for the feed pipe to enter a boiler; but a very common practice is that in which the feed pipe is made to enter the boiler at the front a few inches below the water line, and in a horizontal position parallel to the axis of the boiler. The pipe should extend into the boiler for a distance of from one-half to two-thirds the length of the boiler. The reason for this is that the temperature of the feed water approximates more closely to that of the surface water which is cooler than the water in any other part of the boiler. The water in the boiler is hottest where it comes in contact with the heating surface of the flues or of the boiler shell. Water of a lower temperature should not be injected into the boiler so as to come into immediate contact with these hotter surfaces, as it would cause an unnecessary contraction and expansion of the metal, due to the changing temperature of the water impinging against it, and would tend to injure the joints.

Pumps for Mine Service.

The severe test to which pumps are subjected in mining practice requires extraordinary care and judgment in their design. The demand in many cases for continuous service, under conditions that are at once destructive to the pump and hostile to all classes of machinery, requires not only great strength in the several parts, but a high grade of quality in the material employed in their construction. Prominent among these conditions are the almost invariably corrosive effects of mine water, due to the presence of sulphuric acid, iron, and other impurities in the water. This corrosive action is at times so strong as to destroy the pump linings, valves, etc. in a short period of time, unless these are particularly designed to withstand this action. The pressures under which mine pumps are required to work in a large majority of cases, throw a great burden upon the working parts. Again, the hard usage which this class of pumps receives both in the handling and in the daily operation of the same, would result in serious damage and incapacitate the pump for service if it were not designed with special reference to these conditions.

The selection of a pump for any particular work in mining practice is often a matter beset with difficulty on the part of the superintendent owing to his lack of acquaintance with certain essential features in regard to pumps for such service as he requires. We will outline briefly a few of the more important features of pumps.

Single or Double Acting Pumps.—This feature relates to the piston or plunger of the pump acting in one or both directions. In the *single acting pump* the water is drawn into the pump barrel or cylinder in one stroke and is forced from there into the delivery pipe in the succeeding or return stroke. This type of single acting pump is represented by the well known Cornish system which consists of a number of ponderous plungers operated by a common pump rod or beam hanging in a shaft, each plunger lifting the water from its own station to the station next higher. The entire system is cumbersome and unscientific, and has nothing to recommend it aside from simplicity of construction, except only in its adaptation to very deep shafts where it has proven an efficient and economical means of caring for the water. In *double acting pumps* the piston or plunger acts simultaneously upon the suction and delivery columns, the water being drawn into one end of the pump barrel at the same time that it is expelled from the other end. This is the common form of mine pump, and is adopted in preference to the single acting pump on account of reducing the shock and jar due to the water column coming to rest at the end of each stroke, as it must invariably do in a single acting pump, notwithstanding the compression chamber, which is seldom large enough to maintain a constant flow in a single acting pump.

Single, Duplex, or Triplex Pumps.—Pumps belong to either one of these three classes according as there are one, two, or three distinct pumps discharging into a common delivery pipe. A *single pump* is one that consists of a single water cylinder connected with one or more steam cylinders. If there are two water cylinders, each connected with its respective steam cylinder, the pump is *duplex*; if there are three, *triplex*. This feature is of great importance, especially in mining practice. A single pump possesses the disadvantage of relying wholly upon its compression chamber to prevent the shock and jar incident to the reciprocating motion of its piston or plunger. In the duplex type of pump, the two pumps are so connected as to act alternately; the one being at the center of its stroke when the other is at the end, thereby maintaining an almost constant delivery. In the triplex type of pump the shock and jar due to the reciprocating motion are overcome to a still greater degree by the successive deliveries of the three pumps working upon the same delivery column, and maintaining a practically uniform flow in the pipe. In this form of pump the loss of energy due to reciprocating motion is reduced to a minimum and is exceedingly small, especially where a good compression chamber is attached to the pump. If a single pump

were employed, where the lift is considerable the loss of energy from this cause would be large. For this reason single pumps are not in general adapted to mine work, the common form being the duplex; and in many cases triplex pumps are used.

Simple or Compound Pumps.—*Compound pumps* are those having two or more steam cylinders in distinction from a *simple pump* which has but one. These cylinders are placed tandem to each other and operate the same pump stem, which is connected with the piston or plunger. Pumps of this class may be *double expansion* or *triple expansion pumps*, according as they possess two or three steam cylinders placed tandem upon the same pump stem. In this form of pump the steam is used expansively, which results in a large saving of steam and makes this pump the most economical in use.

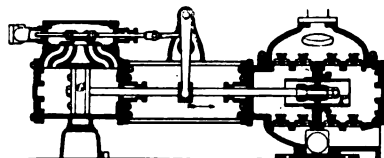


FIG. 1.

The initial cost of compound pumps is necessarily much greater than that of simple pumps, but the saving of fuel soon compensates for this increased outlay, in large pumping systems. In compound pumps the steam from the boiler enters the smaller or high pressure cylinder where it undergoes a partial expansion, and is exhausted from there into the second or low pressure cylinder where it completes its expansion. The areas of these two cylinders are made approximately inversely proportional to their respective mean effective pressures. The advantage of this feature of double and triple expansion is the decrease in the amount of initial condensation in the cylinder. Where the steam performs all of its work of expansion in one cylinder, as in a simple engine, the low temperature at the end of the stroke resulting from this expansion cools the cylinder much below the temperature of the entering steam, a considerable percentage of which is condensed as it enters the cool cylinder. This is called initial condensation. In compound engines the steam is allowed to expand only partially in each cylinder, and as a consequence the difference of temperature between the entering and exhaust steam is less and the initial condensation correspondingly small. The expansive force of all the steam is utilized in this type of engine, and a great saving results from the decrease in condensation.

Piston or Plunger Pumps.—Another important feature is that which distinguishes pumps as belonging to the *piston* or the *plunger type*. These two types of pump differ radically from each other not only in their form but in their adaptation to particular conditions. The essential practical difference that interests the consumer, lies in the reduced first cost of pumps of the piston type. These two forms of pumps are shown in section in Figs. 1 and 2. Pumps of each of these types are made by all manufacturers. In many cases a piston pump is selected owing to the reduced first cost, where a plunger pump would give better service. In general it may be stated that the adaptation of the piston pump (Fig. 2), in mining practice, is limited to lifts not exceeding 250 or 300 feet. The form of construction of the plunger pump (Fig. 1) admits of greater strength, and this form of pump is better adapted to great lifts.

Briefly the advantages of pumps of the piston type may be stated as follows: (1) Less initial cost. (2) Greater capacity for the same space. Some other advantages are claimed, such as higher piston speed obtainable owing to the decreased weight of the moving parts. It is also claimed that owing to the complete submergence of the piston, due to placing the suction valves above the cylinder instead of below as in the plunger type, there is obtained greater efficiency in the pump.

Piston Pumps.—The adaptation of this type of pump to mining practice is as we have remarked, limited to small lifts not exceeding 300 feet. Of necessity there is in the piston type but one style of pattern and this is inside packed. The form of packing in general use is the patent ring packing. The patent air expansion packing has been used in some of these pumps and proven quite serviceable, but this form of packing has not as yet come into general use. Inside packing in any form of pump, while reducing the initial cost of the pump, possesses the disadvantage of requiring the drainage of the pump and removal of the cylinder head before it can be replaced. It is claimed by some that inside packing is more serviceable than

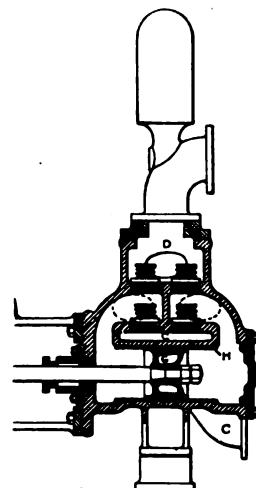


FIG. 2.

outside packing, in some instances lasting longer and proving equally efficient. When, however, the water is especially gritty or acid in character outside packing is commonly preferred owing to the necessity of replacing the packing frequently.

Plunger or Ring Pumps.—Of this type there may be mentioned three different styles, differing from each other in the manner of packing the plunger.

(1) The *inside packed plunger pump* (Fig. 1) is built with special adaptation to high pressures. The initial cost of the pump is reduced by this form of packing. Where the water is clear and not especially corrosive, it furnishes a very efficient pump, at a reduced cost.

(2) The *outside, end packed, plunger pump* Fig. 3, is likewise adapted to high pressures and is a more efficient pump, and one usually preferred where scouring of the cylinder occurs from gritty water, necessitating the frequent replacing of the packing. In many pumps of this type this can be accomplished without the stoppage

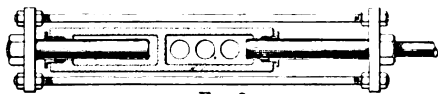


FIG. 3.

of the pump. Both ends of the pump barrel are supplied with stuffing boxes encircling the plunger. In this form of pump there are two plungers working end to end in two separate compartments of the same pump barrel. The two plungers are usually connected by outside rods or stems, the same movement being imparted to each by the steam piston.

(3) The *outside, central packed, plunger pump* is perhaps the best form of mine pump. It is adapted to high pressures, and possesses all of the advantages of the type just mentioned, with the additional advantage of possessing greater stability, and maintaining its alignment more perfectly. This type of pump for mine use is coming rapidly into favor. The two plungers in this pump are connected to each other by a central pump stem, or form one and the same cylinder or plunger working in two distinct pump barrels, as in the end packed pump. The outside rods connecting the two plungers in the latter type, are here replaced by a single pump stem extending from the steam cylinder through one end of the first pump barrel, to the plunger.

Almost all of the different pump manufacturers make these several forms of pumps, differing from each other in minor details, each of which possesses more or less advantage and forms the distinguishing characteristic of the different makes.

Gravity Planes—Number of Cars Required.

An important question in the operation of a gravity incline is the determining of the number of cars necessary to run in a trip in order to successfully operate the plane. We referred in a previous article to the manner of determining the opposing forces or the contending pulls upon the rope in the operation of an incline, but did not refer to the manner in which the number of cars necessary for a given incline should be calculated.

The pull upon the rope producing motion is the gravity pull of the net or live load. The gravity pulls of the cars balance each other, since there are the same number of cars ascending as descending the incline. The pulls upon the rope resisting motion are the gravity pull of the rope and the friction pull of the entire moving system (cars, load, and rope).

Let n = the number of loaded or empty cars in a trip,

W = weight of one car (lb.),

w_c = the weight of coal in one car (lb.),

w_r = weight of rope per lineal foot (lb.),

l = unbalanced length of rope, or length of incline,

a = angle of inclination of the plane.

μ = coefficient of rolling friction,

r = ratio of live load to dead load for each loaded and empty car $\left(\frac{w_c}{2W}\right)$,

r_1 = ratio of weight of rope to weight of two cars $\left(\frac{w_r l}{2W}\right)$.

Then, equating the contending pulls upon the rope, or the pulls producing and resisting motion, we have,

$$n w_c \sin a = w_r l \sin a + \mu (w_c + 2W) n + \mu w_r l.$$

Or transposing and factoring,

$$n w_c (\sin a - \mu) = w_r l (\sin a + \mu) + n \mu (2W).$$

Then, dividing both members of this equation by $2W$, remembering that $\frac{w_c}{2W} = r$, and $\frac{w_r l}{2W} = r_1$, we have,

$$n r (\sin a - \mu) = r_1 (\sin a + \mu) + n \mu.$$

And finally, for the value of n we have,

$$n = \frac{r_1 (\sin a + \mu)}{r (\sin a - \mu) - \mu}. \quad (1)$$

In any gravity system there is always the same number of ascending and descending cars; and for each pair of cars (loaded and empty), there is a certain ratio between the live and dead load. We have called this ratio $\frac{w_c}{2W} = r$. Again, according to

the length of the plane and the size or weight of rope required, the weight of the rope will, also, bear a fixed ratio to the dead weight of each two cars, loaded and empty. We have called this

ratio $\frac{w_r l}{2W} = r_1$.

In the calculation of any gravity system we must first determine the values of these fixed ratios for that system; and then we can determine by equation (1) the number of cars to be run in a trip in order to successfully operate the system, for any given angle of inclination. Or by solving the above formula with respect to a , we can determine the angle of inclination necessary, in order to run any number of cars in a trip, when we know the length and size of rope and the ratio between the live and the dead load, for each pair of cars. This formula is:

$$\sin a = \frac{\mu (r n + r_1) + n \mu}{(r n - r_1)}. \quad (2)$$

EXAMPLE.—Determine the number of cars to be run upon an incline 800 feet long and having an inclination of 3° , when the cars weigh 900 pounds each and have a capacity for 1,600 pounds of coal.

SOLUTION.—Assuming a $\frac{3}{4}$ " steel rope weighing .57 pound per lineal foot, we find for the values of the ratios, as follows:

$$r = \frac{w_c}{2W} = \frac{1,600}{2 \times 900} = .889,$$

$$\text{and } r_1 = \frac{w_r l}{2W} = \frac{.57 \times 800}{2 \times 900} = .253.$$

Substituting these values in the above equation (1) for the value of n , and calling the coefficient of rolling friction $\mu = .025$, we have, since $\sin 3^\circ = .0523$,

$$n = \frac{.253(.0523 + .025)}{.889(.0523 - .025) - .025} = 8.33, \text{ say 9 cars.}$$

A little study of equations 1 and 2 will be interesting and helpful. For example, the equation 1, we see that whenever the value of $\sin a$ is less than the value of μ , or the coefficient of rolling friction, the denominator of the fraction will reduce to zero; which shows that an infinite number of cars would be required upon a plane of such inclination. Therefore, we observe that the angle of inclination of the plane must always be such that its sine is greater than the coefficient of rolling friction. Again, in the same equation, we see that the value of $r (\sin a - \mu)$ must be greater than μ or the angle of rolling friction; which shows that as the ratio (r) between the live load and the dead load of the cars decreases, we must increase $\sin a$, and *vice versa* as this ratio increases we may decrease $\sin a$. In other words, when the ratio of live load to dead load is high the inclination of the plane may be decreased, but as this ratio is lower the inclination of the plane must be correspondingly increased. Suppose for a moment that this ratio is 1, as when a thousand pound car has a capacity for 2,000 pounds of coal, then $\sin a$ must be greater than 2μ , or twice the rolling friction. This makes known to us certain limits of the inclination of the plane below which it cannot be operated as a gravity plane, and we observe that these conditions are dependent not only upon the coefficient of rolling friction and the inclination of the plane, but as well upon the two ratios, that of the live load or material to the dead load of cars, and that of weight of rope to the weight of cars. Again, studying equation 2 we see that when $r n$ is equal to r_1 the value of the denominator of the fraction becomes zero, giving an infinite value for $\sin a$, or the plane would be a vertical plane. As $r n$ is greater than r_1 the inclination of the plane decreases. In long inclines r_1 is increased and a larger number (n) of cars is required, or the angle of inclination (a) is much increased.

For convenience we have calculated the angle of inclination for the uniform grade of gravity planes, for different weights and capacities, assuming that the rolling friction is $\frac{1}{40}$ of the weight of the moving load ($\mu = .025$). The table on page 285 shows the angle of inclination required for trips of 1 and 10 cars, respectively, in each case. This number of cars has been taken to show the limiting grades for the incline, under the varying conditions arising from the length of incline and the weight and capacity of the cars. Less than one car cannot be used, and it is seldom that more than ten cars are lowered upon an incline at one time.

The angle of inclination given in the table is for that portion of the plane having a uniform grade, and is the inclination required to maintain the velocity imparted to the system by the starting grade, or the steep pitch at the head of the incline. The inclination of the steep pitch must be such that the gravity pull of the loaded trip will be equal to the gravity pull of the rope

upon the uniform grade and the friction pull of the entire system in starting. The coefficient of static resistance when starting, we may assume as double the coefficient of rolling friction, or 2μ . Writing these expressions denoting the angle of inclination of the steep grade at the head of the incline, by β , we have,

Gravity pull of loaded trip = $n(w_c + W) \sin \beta$,

Gravity pull of rope (uniform grade) = $w_r l \sin \alpha$,

Friction pull of entire system when starting = $2\mu [n(w_c + 2W) + w_r l]$.

The gravity pull of the empty trip when starting will be zero, inasmuch as the trip is standing upon the level track at the foot of the incline. This level track is about equal in length to the length of the steep pitch at the head of the incline. We may calculate these resisting pulls upon the rope and find the value of β , or we may equate their values as given above and solve the equations with respect to $\sin \beta$, which will give a formula for determining the angle of inclination of the steep pitch; thus,

$$\sin \beta = \frac{2\mu n(r+1) + r_1(\sin \alpha + 2\mu)}{n(r+.5)}. \quad (3)$$

When the trip is at the head of the steep pitch the resisting forces pulling upon the rope are in equilibrium, and the trip is readily started down the incline gaining impetus or being accelerated as it goes. As soon as the system is started the coefficient of resistance becomes the coefficient of rolling friction, or the resistance drops to, say, one-half of that required for starting. The descending pull is also being constantly increased by the gravity pull of the rope that has passed over the pulley and is now descending with the loaded trip. This acts constantly to assist the movement of the system, all the way down the plane, thus providing an excess of force in favor of the descending load. This excess of force or as much of it as is not absorbed by the in-

pressing the time of acceleration. Equating these two values we find the expression for the length of the steep pitch that will produce a velocity v ,

$$l = \frac{v^2}{2f}. \quad (5)$$

To make the application of these formulas more clear let us take a practical example.

EXAMPLE.—Suppose an output of 1,000 tons per day of 10 hours is being delivered at the head of an incline 7,500 feet in length and having an inclination of $5^\circ 30'$. The cars weigh 1,500 pounds and carry 2,500 pounds of coal, each. We desire to know the number of cars that should be run in a trip, and the length and inclination of the steep pitch at the head of the incline.

SOLUTION.—In gravity plane calculations the size of rope is determined more by the wear to which it is subjected than by the load it carries. For this reason we may assume such a size of rope as judgment dictates, and determine its factor of safety later. In the present case we assume a $\frac{3}{4}$ " steel rope weighing .88 pound per lineal foot and having a breaking strain of 25 tons. The first step in the problem is to determine the number of cars that should be run in a trip, upon this incline. We first determine the values of the ratios r and r_1 , thus,

$$r = \frac{w_c}{2W} = \frac{2,500}{2 \times 1,500} = .833.$$

$$\text{and, } r_1 = \frac{w_r l}{2W} = \frac{.88 \times 7,500}{2 \times 1,500} = 2.2.$$

Then, substituting the given values in equation 1, using a coefficient of friction $\mu = .025$, we have, since $\sin 5^\circ 30' = .0959$,

$$n = \frac{2.2(.0959 + .025)}{.833(.0959 - .025) - .025} = 7.809, \text{ say 8 cars.}$$

TABLE SHOWING THE ANGLES OF INCLINATION REQUIRED FOR GRAVITY PLANES 1,000 FEET LONG, AND CARS OF DIFFERENT WEIGHTS AND CAPACITIES.

Weight of car (Lb.)	No. of cars in a trip.	Size of rope (Inches.)	Weight of rope Lb. per lineal foot.	Capacity of car (Lb.).												
				1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,500	3,000	3,500	4,000	4,500	5,000
				Angle of Inclination required to maintain velocity of cars.												
600	1	1	810	5° 13'	4° 22'	3° 50'										
	10		810	3° 14'	2° 59'	2° 45'										
800	1	1	810	6° 03'	5° 02'	4° 21'	3° 54'	3° 34'								
	10		810	3° 53'	3° 28'	3° 10'	2° 57'	2° 47'								
1,000	1	1	810		5° 40'	4° 53'	4° 21'	3° 57'	3° 39'							
	10		810		3° 58'	3° 36'	3° 19'	3° 06'	2° 56'							
1,200	1	1	570			7° 35'	6° 23'	5° 44'	4° 59'	4° 33'	4° 04'					
	10		570			4° 07'	3° 46'	3° 30'	3° 17'	3° 07'	2° 54'					
1,400	1	1	570				7° 11'	6° 02'	5° 24'	4° 54'	4° 35'	3° 47'				
	10		570				4° 13'	3° 50'	3° 35'	3° 23'	3° 09'	2° 51'				
1,600	1	1	570					6° 29'	5° 47'	5° 15'	4° 38'	3° 59'	3° 33'			
	10		570					4° 09'	3° 53'	3° 39'	3° 21'	3° 03'	2° 49'	3° 33'		
1,800	1	1	880						8° 18'	7° 16'	6° 11'	5° 03'	4° 22'	3° 54'		
	10		880						4° 16'	3° 56'	3° 41'	3° 06'	3° 01'	2° 49'	3° 43'	
2,000	1	1	880							7° 42'	6° 15'	5° 20'	4° 35'	4° 05'	3° 43'	
	10		880							4° 16'	3° 55'	3° 29'	3° 11'	2° 54'	2° 47'	
2,500	1	1	880									6° 01'	5° 08'	4° 32'	4° 07'	3° 07'
	10		880										3° 59'	3° 36'	3° 20'	2° 57'
3,000	1	1	880										5° 41'	4° 30'	4° 08'	3° 04'
	10		880											4° 02'	3° 42'	3° 26'	3° 04'

equalities of the road must be controlled by the brake. While the loaded trip is moving down the steep pitch, acceleration takes place continuously. According to the velocity which it is desired to attain, the length of the steep pitch is increased or decreased. To ascertain the length of the steep pitch we must first calculate the acceleration of the system due to the resisting pulls, as explained in the article "Haulage," page 522, MINES AND MINERALS, June, 1900. Thus,

- Let f = acceleration of the system (ft. per sec.),
 g = acceleration due to gravity (32.16 ft. per sec.),
 v = uniform velocity to be attained (ft. per sec.),
 p_1 = descending pull (lb.),
 p_2 = sum of the resisting pulls (lb.),
 l = length of steep pitch (ft.).

The acceleration of the system is calculated from the formula

$$f = \frac{p_1 - p_2}{p_1 + p_2} \times g. \quad (4)$$

But, since the acceleration (f) is the gain in velocity each unit of time, $\frac{v}{f}$ = the time of acceleration. But the space passed over while the body is being accelerated from a state of rest to a velocity v , would be the same if the body moved with a uniform velocity $\frac{v}{2}$. And since this space passed over during acceleration is

the length (l) of the steep pitch, we have $l + \frac{v}{2} = \frac{2l}{v}$, also, ex-

The second step is to determine the velocity at which the cars should be run, or the time of making one trip. Thus,

$$\frac{8 \times 2,500}{2,000} \times \frac{10 \times 60}{1,000} = 6 \text{ minutes per round trip.}$$

Now, allowing one minute between trips for change of ropes and loss of time in starting and stopping, we have $6 - 1 = 5$ minutes, actual time of running, for one trip; and for the uniform velocity, we have,

$$v = \frac{7,500}{5 \times 60} = 25 \text{ ft. per sec.}$$

$$\text{or, } \frac{25 \times 60 \times 60}{5,280} = \text{say 17 miles per hour.}$$

The third step is to determine the grade of the steep pitch at the head of the incline, and also the length of this steep grade that will produce the required velocity. Substituting the given values in equation 3, we have for the angle of inclination of the steep pitch

$$\sin \beta = \frac{2 \times .025 \times 8(.833 + 1) + 2.2(.0959 + 2 \times .025)}{8(.833 + .5)} = .0988,$$

and $\beta = 5^\circ 40'$.

The length of this steep grade will depend upon the acceleration of the system, which is calculated by means of formula 4. We must first determine the values of p_1 and p_2 , respectively.

Thus,

$$p_1 = n(w_c + W) \sin \beta = 8(2,500 + 1,500) .0988 = 3,162 \text{ lb.},$$

$$\text{and, } p_2 = n(w_c + 2W) \mu + w_c l (\sin \alpha + \mu) = 8(2,500 + 3,000) .025 + .88 \times 7,500 (.0959 + .025) = 1,898 \text{ lb.}$$

Substituting these values in equation 4, we have,

$$f = \frac{3,162 - 1,898}{3,162 + 1,898} \times 32.16 = 8.034 \text{ ft. per sec.}$$

Then, for the length of the steep pitch, we have,

$$l = \frac{v^2}{2f} = \frac{25^2}{2 \times 8.034} = 38.9 \text{ ft.}$$

Bartlett Coal Carrier.

The Bartlett coal carrier, illustrated herewith, and built by C. O. Bartlett & Co., of Cleveland, Ohio, is operated as follows:

The coal to be loaded on the boat is first loaded on hopper bottom railroad cars and drawn on the trestle shown at the right hand side of the illustration. The coal is dumped into a large iron hopper underneath the car and over the lower end of the carrier, the coal being fed onto the carrier by means of a large slide, or opening three feet square, opened and closed by power. The coal is then conveyed up this continuous carrier and delivered into the spout which feeds the coal into the boat from the carrier. This spout is so arranged that it may be swung in any direction, thus doing away with the necessity of trimming the boat by hand, the coal being delivered at any point required.

The upper end of the carrier is supported by a tower and is hung on a hinge so that the upper end can be raised or lowered as desired i. e. when it is desired to move the boat along, the upper end of the carrier can be hoisted high enough to be out of the way of the vessel and quickly lowered again. It can be raised to an upright position by the cable, if so desired, and be entirely out of the way of any moving vessels. The spout for spouting the coal into the vessels from the carrier is made to telescope, so that as the boat is filled with coal the spout itself may be kept constantly full of coal, thus bringing to a minimum the breakage of the coal. The raising and lowering of the outer end of the carrier is an important feature of this loader as by this means it can be accommodated to any boat, while the breakage is a minimum as the coal falls but a short distance. The whole carrier and mechanism pertaining thereto is operated by a 9×12 inch plain slide valve engine, or, in other words, it takes less than 25 H. P. to operate this entire coal loading machinery. Everything is necessarily made strong and substantial.

One of the principal objects of this loading device was to use very little labor. It requires to operate it the following: one



LOADING A VESSEL WITH BARTLETT COAL CARRIER.

engineer who takes entire charge of machinery, including the running of the engine; one man to see that it is properly fed, and one man to operate the swinging or delivery spout at the delivery end of the carrier.

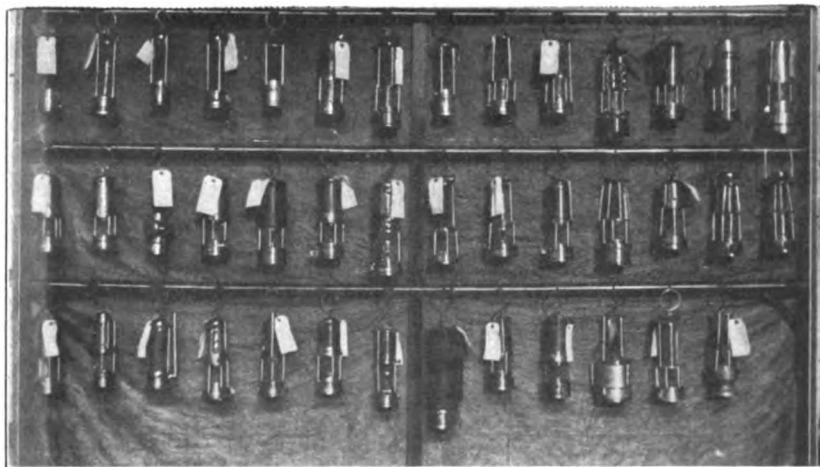
The conveyor was sold under a guarantee to load 600 tons an hour, but has loaded as much as 900 tons per hour. The actual

cost of the entire outfit was less than one-tenth of other loading devices now used at Ashtabula and the power required to run it is about one-fifth of what is required to run the others. The plant here illustrated was built for M. A. Hanna and Co., at Ashtabula, Ohio, at a cost of less than \$5,000.

In view of the low initial cost of this plant, its economical operation and its efficiency it should receive the very careful consideration of all large coal operators.

Safety Lamp Exhibit.

The illustration given herewith shows a very interesting exhibit of safety lamps made by The International Correspondence Schools, of Scranton, Pa., at the Pittsburg Industrial Exposition, held from September 5th to October 20th, 1900. This exhibit consisted of 41 different safety lamps as follows: Nos. 1, 2, 3, 4, 5, 6,



SAFETY LAMP EXHIBIT AT PITTSBURG.

were Davy Lamps; 7, 8, 9, 10, 11, Clanny Lamps; 12 Wolf Lamp; 13 Dick Lamp; 14 Thompson's Acetylene Lamp; 15 Derbyshire Clanny Lamp; 16 Garforth Lamp; 17 Bull's Eye Clanny Lamp; 18, 19, 20, 21, Marsaut Lamps; 22, 23, 24, 25, Mueseler Lamps; 26 Ashworth Patent Lamp; 27 Gray Lamp; 28 Ashworth-Hepplewhite-Gray Lamp; 29, 30, Bonneted Davy Lamp; 31 Richards Lamp; 32, 33, 34, 35, Special Testing Lamps; 36 Pieler Lamp; 37 Marshall Lamp; 38 Clifford Patent Lamp; 39, 40, Cosset Lamps; and 41 Cambessedes Lamp.

A pamphlet of 32 pages was also distributed giving a brief history of the safety lamp, a description of the principle gases occurring in mines, an explanation of the principles of action of safety lamps, a description of the chief types of safety lamps, and a somewhat detailed description of each lamp in the exhibit.

The Uses of Glue.

Glue is said to greet you in your cradle, and to bid you adieu in your coffin. We don't suppose a tenth of the people stop to think how variously glue serves them. It's in their hats and shoes, their carpets and furniture, their pencils, paper, pastry, confectionery and medicine, on their walls, in the stiffening of their apparel, and practically in or on some dozen or more articles with which they have daily dealings. Sixty million pounds of it are used a year, the cheapest at 9c., and the dearest, which is used in pharmacy and the confectionery trade, at about 90c. Glue stock is very hard to get now, owing to a change in the practice of tanners since leather went up. Formerly they trimmed off the best hides about square, giving the glue manufacturers the entire covering of legs, tail and head, but now they sacrifice only small pieces about the eyes and a little of the head. The result has been an advance, since 1893, from \$7.50 to \$35 per ton for the wet glue stock, which has caused an advance of about 50 per cent. in the manufactured article. The center for manufacture of low-grade glue is Chicago, and for high-grade, Peabody, Mass. In the industries, it is used almost universally. Alcohol, turpentine and coal oil barrels have to be sized with it, and wooden boxes for merchandise, made of small pieces, are joined with it, while, of course, it is used throughout the furniture trade. Newspaper printing paper is made without glue, but any paper that is to be written on with ink, or presents a smooth finish, has to be treated with it at some stage in the manufacture.—*Industrial Advocate*.

NEW INVENTIONS.

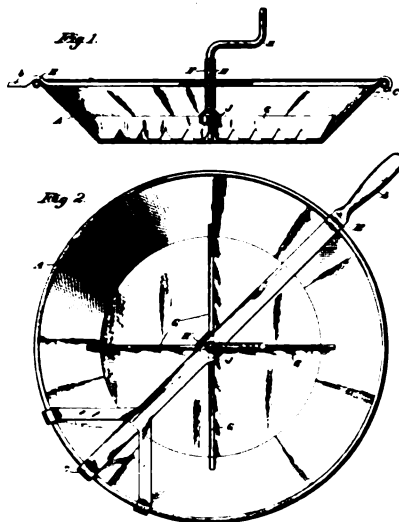
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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MINERS' SEPARATING PAN.

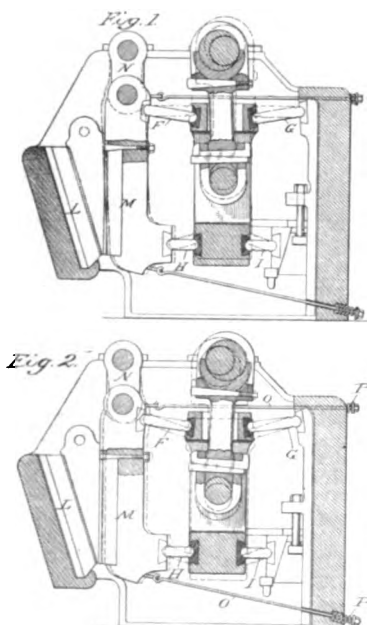
No. 659,237. A. J. KETELSEN, CHICAGO, ILL. Patented Oct. 9, 1900. The device covered by this patent and illustrated by the accompanying



tended is as follows. The miner will take a pan full of dirt and wash off all of the lighter material, leaving only the magnetic black sand and the gold. The magnetic black sand will then be removed by introducing the magnetic separator and revolving it so as to attract the magnetic black sands.

CRUSHING MACHINE.

No. 657,958. E. REYNOLDS, MILWAUKEE, WIS. Patented Sept. 18, 1900. This patent, illustrated by Figs. 1 and 2, relates to a means of moving the jaw of a rock crusher so as to obtain the greatest efficiency therefrom. In Fig. 1 the eccentric is shown in full lines intermediate of its highest and lowest points, in which position the toggles *H* and *I* lie in a horizontal plane while the toggles *F* and *G* are inclined downward. In this position the lower end of the jaws *L* and *M* are in their nearest position. As the eccentric makes a quarter revolution, passing to the top, the toggles *H* and *I* assume the inclined positions indicated by the dotted lines thus drawing the lower end of the jaws *M* and *L* apart and allowing the fine material to discharge. At the same time the toggles *F* and *G* assume a horizontal position as indicated by the dotted lines, thus subjecting the coarse material between the upper portion of the jaws to a crushing action. As the eccentric continues to revolve into a horizontal position upon the other side of the center, as shown by the full lines in Fig. 2, the toggles *F* and *G* assume an inclined position as shown by the full lines and the toggles *H* and *I* come once more to a horizontal position thus subjecting the ore to a crushing action at the lower portions of the jaws *M* and *L*. As the eccentric continues to revolve and comes to the lower position as indicated by the dotted lines,

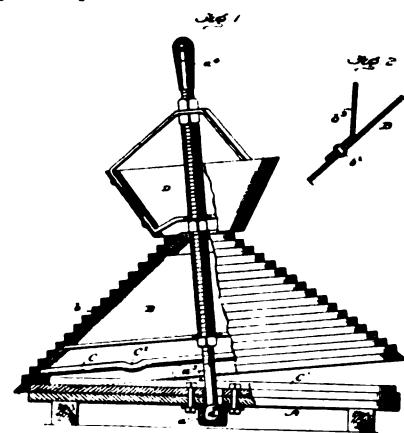


horizontal position thus subjecting the ore to a crushing action at the lower portions of the jaws *M* and *L*. As the eccentric continues to revolve and comes to the lower position as indicated by the dotted lines,

Fig. 2, the toggles *H* and *I* come to the inclined position indicated by the dotted lines in Fig. 2, thus allowing the fine ore to discharge again, while the toggles *F* and *G* assume a greater inclination than previously, as indicated by the dotted lines. Another quarter revolution brings the parts into the relationship shown by the full lines in Fig. 1. From this it will be seen that during a complete revolution of the crank shaft the lower portion of the jaws is given two crushing impulses while the upper portion is given but one and that there are two opportunities for the crushed material to feed from between the jaws for each revolution. This will tend to overcome the difficulty experienced in many jaw crushers on account of the fact that the coarse material was reduced more rapidly in the upper portion of the space between the jaws than it could be further crushed and discharged from between the lower ends of the jaws. In the form shown in the illustration, the jaw *M* is supported by a link *N* so that it is free to assume any position as governed by the toggles. The bars *O* at the top and bottom of the machine are kept in tension by the springs *P* and thus serve to retain the jaws against the toggles.

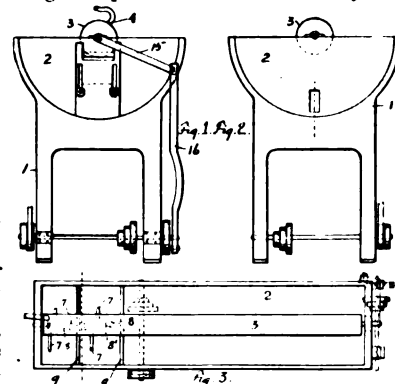
ORE SEPARATOR.

No. 658,947. W. J. GOYNE, BARTON HEIGHTS, VA., AND W. H. GOYNE, GOYNE, PA. Patented Oct. 2, 1900. This patent illustrated by Figs. 1 and 2 has for its object the production of an efficient and at the same time light apparatus for separating gold from placer sand or tailings or for concentrating the valuable constituents in similar material. It consists of a cone upon which is arranged a series of metal rings *b* which form concentric grooves or pockets. The detail of these rings is shown in Fig. 2, *b* being the piece to form the ring and *b'* the rivets for securing it. The ore or tailings are charged into a hopper *D* which distributes them to the top of a separator. Water is introduced with the material and the entire apparatus is given an oscillating motion by means of the handle *a*. The cone and hopper are supported upon a vertical shaft *a'* provided with a ball bearing *a''* at the bottom which fits in the socket *a'*. This shaft is threaded throughout its entire length and the cone and hopper are adjusted by means of nuts as shown. To the under side of the cone *B* there is attached a ring *C* which runs upon the track *C'* upon the supporting base *A*. This ring is provided with corrugations *C''*. These corrugations give the cone a vibrating or jolting motion as they pass over the ring *C'*. It will be readily seen that the material under treatment will be subjected to a circular or vanning motion and at the same time to a vibrating action. As the material passes down over the cone each succeeding annular space is of greater length than the previous and so there is very little opportunity for gold or other material of value to escape, while the tailings are readily discharged over the periphery. The patent also covers an alternative scheme of inverting the cone and introducing the concentric rings on the inside.



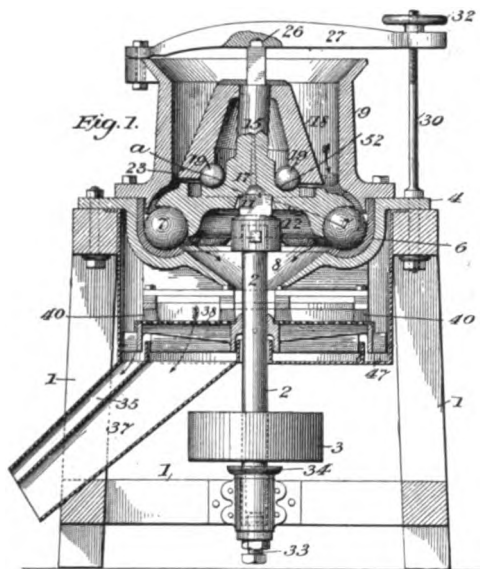
ORE WASHER AND SEPARATOR.

No. 659,813. E. W. EATON, SOCORRO, N. M. Patented Oct. 16, 1900. The apparatus covered by this patent consists of a trough *2* mounted upon a suitable support *1*, as illustrated in Figs. 1, 2 and 3. Supported upon bearings at the ends of the troughs there is a hollow cylinder *3*, which is supplied with water by means of the flexible pipe *4* and is given an oscillating motion through the portion of a revolution by the lever *15* and connecting rod *16*, or by any other suitable mechanism. The ore is introduced at the left hand end of the trough shown in Fig. 3. This end of the trough is provided with two partitions *9* extending from the top of the trough to below the surface of the water. This forces all of the ore to pass under these partitions on its way to the discharge end. The material is thoroughly disintegrated by means of the bars *7* and is washed by means of jets of water from the pipes *8* which project down into the ore and have their points turned toward the head of the machine as shown at *8'*. The concentrates discharge through the opening in the bottom of the trough at the end at which the ore is introduced and the tailings are washed free and discharged at the opposite end. The machine may be arranged to discharge intermittently or continuously and may be provided with quicksilver for the amalgamation of free gold.

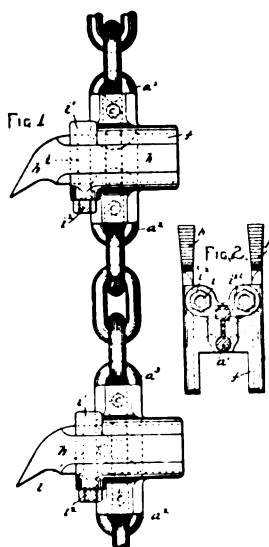


CRUSHING AND PULVERIZING MACHINERY.

No. 657,933. T. R. GOTH, SAN FRANCISCO, CAL. *Patented Sept. 18, 1900.*
The patent illustrated in the accompanying figure consists of an



arrangement intended to utilize the reaction of one part of the machine to meet that of another and thus relieve the driving shaft of practically all strain. The machine consists of a supporting frame 1 carrying a vertical shaft 2 which may be driven by a pulley 3 or any other suitable mechanism. This shaft is supported upon a step bearing at 34 which may be adjusted by means of a screw 33. At the top of the shaft is placed a casting 12, carrying the block 11 upon which a semi-spherical piece is placed. This piece serves as a bearing for a head 17 by means of which the driving is done. The piece 11 is rectangular and fits into the rectangular slot in the head 17 thus insuring the rotation of the latter. The upper portion of the piece 17 is arranged as a spindle 15 placed at an angle to the axis of the shaft 2. The piece 17 is also provided with a race 52 for the balls 19. This race is placed in a plane perpendicular to the inclined axis of the spindle 15 so that the crushing head 18 which rests upon the balls 19 will rotate about an axis making an angle with the shaft 2. The crushing head 18 is surrounded by a hopper 9 and the ore is fed between the crushing head and the hopper so that it is crushed as in the ordinary gyratory crusher. The crushed ore is discharged through the opening 23 and is still further ground by the balls 7 which rotate between the driving head 17 and the dies 6 which are supported by the casting 4. It will be noticed that the reaction caused by the crushing of the ore by the ball 7 upon the right hand side of the machine will be in the direction of the line *a* and that this will be resisted by the crushing of the coarser material in the hopper upon the left hand side of the crushing head in the hopper 9. In like manner at all points about the machine these reactions will tend to balance each other. The crushed material escapes from the balls through the hopper 8 to the screen 38. Here it is carried toward the edge by a series of spiral brushes 40. The finer portion passing through the screen and into the chute 37 while the coarser portion passes over the edge of the screen into the chute 35 and is returned for further treatment. The lever 27 is arranged to bear upon an extension of the spindle 15, as shown at 26, and the pressure upon this bearing can be adjusted by means of the hand wheel 32 upon the screw 30. By means of the thrust bearing 34 and the bearing 26 the crushing head 18 and the driving head 17 can be made to revolve free of the balls 7 so that the strain upon the machine will come entirely from the crushing.



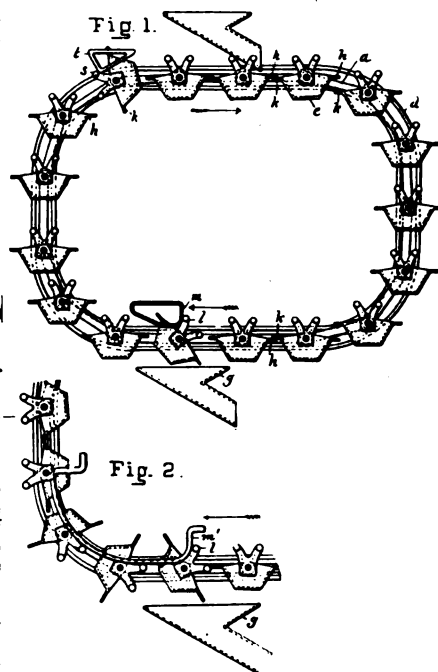
CUTTING CHAIN FOR MINING MACHINES.

No. 659,348. H. H. MERCER, CLAREMONT, N. H. *Patented Oct. 19, 1900.*
This patent covers an arrangement for attaching mining cutters to an ordinary forged chain, and is illustrated in Figs. 1 and 2. The cutters *h* are carried in blocks *f*, these blocks being formed in halves and secured in place by rivets *c*. It will be noticed that the blocks entirely surround one link of the chain as *a'* and partially enclose two other links, as *a''* and *a'''*. The cutters are held in place in the blocks by means of the bolts *i*, having special hook heads *j*, and nuts *j*. In the form shown in Fig. 2, only two cutters placed side by side are employed. The patent covers various

alternative schemes for fastening a larger number of cutters and for arranging the blocks so that it takes the place of one link in the chain. The principal advantage claimed for this style is that the block can be removed and replaced without disconnecting the chain and that each individual block has to carry only the load caused by its own cut and does not have to carry the strain of the entire chain.

CONVEYOR.

No. 660,451. G. W. McCASLIN, HOBOKEN, N. J. *Patented Oct. 23, 1900.*
This invention relates to a device for tipping buckets at certain points in their travel so that the edges which lap over each other will assume such a relation as will enable them to pass along the upper portion of their travel down to the lower portion and along it without having any tendency to turn over. There are two general devices covered by the patent, which are illustrated in accompanying figures.



In Fig. 1 the buckets *e* are carried upon a chain composed of links *a*, the buckets being supported at the joints of the chain. The chain is carried upon suitable wheels running in guides *d*; the buckets are provided with lips *h* and *k* which prevent any material falling between the buckets while they are being charged. At the upper portion of the travel the lip *h* is above the lip *k*, but when the buckets descend the right hand portion of figure and come to the bottom the lip *k* comes above the lip *h*. If this state of affairs were allowed to continue, when the buckets came to ascend at the left they would be overturned. To prevent this a stationary cam *m* has been placed as shown and the lugs *l* upon the buckets come in contact with this, thus dumping the contents of the bucket into the hopper *g* and raising the advance lip of the bucket until the next bucket before it has started on the ascent so that it will not interfere with the advance lip of the bucket in contact with the cam. This cam *m* may not be used for dumping, but simply for tilting the buckets, the buckets being dumped by another cam. At the upper portion of the bucket travel, the cam *t* is inserted so that it will come in contact with the lugs *s* and overturn the bucket so that the lip *k* will come under the lip *h*. In Fig. 2 the parts bear very much the same relation, except that in place of the two cams *m* and *t* shown in Fig. 1, there is a cam *m'* which is continued for some distance as shown. This cam comes in contact with the lugs *l* on the buckets and turns the latter entirely over, thus bringing the lips *h* and *k* into their proper relationship with each other.

PATENTS ISSUED DURING NOVEMBER AND NOT ILLUSTRATED.

- No. 661,074. Process of extracting precious metals from their ores, H. J. Phillips, London, Eng.
- No. 661,086. Ore-concentrator, A. H. Stebbins, Little Rock, Ark.
- No. 661,144. Ore stamp-mill, M. H. Hamm, Petaluma, and H. R. Taylor, Oakland, Cal.
- No. 661,443. Process of producing artificial stone, E. Coulon, Bleton, Belgium.
- No. 661,617. Crushing-roll, E. W. McCanna, Anaconda, Mont.
- No. 661,683. Rock-drill cylinder-head, A. Ball and T. Officer, Claremont, N. H.
- No. 661,684. Rock-drill cylinder-head, A. Ball and T. Officer, Claremont, N. H.
- No. 661,686. Engine for rock-drills, A. Ball and T. Officer, Claremont, N. H.
- No. 661,825. Rock-drilling engine, W. C. Stephens.
- No. 661,842. Conveyor, H. W. Blaisdell, Yuma, Ariz.
- No. 661,886. Concentrating table, I. F. Monell, Boulder, Colo.
- No. 661,927. Rock-drill, R. L. Ambrose, North Tarrytown, N. Y.
- No. 661,993. Crushing machine, T. R. Jordan, New York, N. Y.
- No. 661,994. Apparatus for concentrating minerals, etc., T. R. Jordan, New York, N. Y.
- No. 661,995. Amalgamating apparatus, T. R. Jordan, New York, N. Y.
- No. 661,997. Concentrating apparatus, T. R. Jordan, New York, N. Y.
- No. 662,280. Artesian-well drilling mechanism, L. J. McNutt, Jefferson, Ohio.
- No. 662,409. Apparatus for separating gold from magnetic sands, E. Gates, Chevy Chase, Md.
- No. 662,410. Magnetic separation, E. Gates, Chevy Chase, Md.
- No. 662,411. Magnetic separator, E. Gates, Chevy Chase, Md.
- No. 662,412. Magnetic separator, E. Gates, Chevy Chase, Md.
- No. 662,413. Magnetic separator, E. Gates, Chevy Chase, Md.
- No. 662,414. Magnetic separator, E. Gates, Chevy Chase, Md.
- No. 662,609. Gas-producer, J. O. E. Trotz, Worcester, Mass.
- No. 662,646. Coal-drill, M. Hardsoeg, Ottumwa, Iowa.
- No. 662,685. Separator and amalgamator, I. P. Clarke, Alameda, Cal.
- No. 662,731. Mining-elevator, R. Lee, Sherrard, Ill.

Mines *and* Minerals

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NORTON COAL MINES

At Norton, Virginia—A Description of the Mines, the Coal Seams and the Methods of Mining and Handling the Coal.

Written for MINES AND MINERALS, by Robert Fleming Supt.

The Norton Coal Co.'s mines are located at the terminus of the Clinch Valley Division of the Norfolk and Western Railway, which is also the terminus of the Cumberland Valley Division of the Louisville and Nashville Railroad. It is therefore as conveniently located as it possibly could be, as coal can be shipped east to Lambert's Point on the N. & W. R. R., and west to Louisville and other points in Kentucky via the L. & N. R. R.

The No. 1 Mine was opened in 1896 and the coal is opened on what is known as the Upper Banner seam. The total section will average 9 feet with two 6 inch partings, one 3 feet from top and the other 3 feet from the bottom, thus dividing the seam into three benches. The undercutting is all done in the upper parting and in this way the top bench is carried forward 8 to 10 feet. Then the middle bench of coal is taken up and in turn the lower parting and bottom bench of coal. This method of mining keeps the partings and coal separate.

Before this mine was actively opened for marketing the output of coal was supplied to Norfolk and Western engines direct from coaling chutes at the tippie. The company still has this contract and the Louisville and Nashville engines are also supplied with coal. This last addition necessitated the building of additional coaling chutes and now the company can coal 12 engines at once if need be.

The output on cars has been sold exclusively as run of mine coal and has been disposed of principally to the N. & W. R. R. to supply their plants along the line, while a great quantity has been shipped to tide water and west to L. & N. R. R. and other points.

This coal has been used for steaming purposes and its qualities as such a coal have brought a demand for it which is permanent and increasing.

Test for Coke.—The first test for coke made in this region was with coal taken from the above named opening, and from the favorable report of this test some 2,000 coke ovens of the beehive pattern have been built with several hundred under construction in and around this region where the same seam is worked. The quality of coke produced is second to none in the United States for furnace and foundry fuel.

The No. 4 Mine is opened up in what is known in this locality as the Edwards Seam. It is separated from the lower No. 1 seam

by an interval of 40 feet, principally consisting of sandstone. This mine was opened only about a year ago; the seam averages 5 feet thick with a 4 inch parting about 16 inches from the bottom. The quality of coal in this seam is excellent, either as a domestic, steam, gas, or whatever coal is used for. The location of this mine is nearly 1,000 ft. from tippie.

The grade throughout the mines is 5 per cent. in favor of loads. The cars are pulled up the grade by a motor, which drops behind the trip coming down. Trips consist of 12 to 14 mine cars averaging 3,500 lb. coal per car.

Haulage.—About one year ago the company installed an electric plant to haul and mine part

of the output. In this they have been very successful. One motor is all that has been used; a 10 ton Baldwin-Westinghouse. The motor has been running in a distance of 4,500 feet in the No. 1 mine, collecting from two side tracks, and hauling over grades of 2½ per cent. in the mine and 6 per cent. outside from mine to tippie, the latter distance being 350 ft. Over such grades this motor has been pulling from 12 to 15 car trips, 3,500 lb. coal per car, or in other words hauling enough of coal per trip to load a gondola railroad car.

Mining Machines.—All coal in the upper mine is mined by a



No. 4 MINE, UPPER OPENING.



NO. 1 MINE BOILER AND POWER HOUSE.

Link-Belt and by Jeffrey mining machines. Both machines mine to the depth of 5 feet under. Miners are paid by the car to shoot down the coal and load it, prop their rooms, etc. The expense of repairs in both machines so far, is trifling, and I do not think that we have spent five dollars in repairs for both machines in the ten months they have been in operation. Their working parts and movements are practically the same and it requires about the same time to load and unload one machine as the other.

Trolley Line.—The trolley line is constructed throughout with figure-8 00 hard-drawn copper wire, which is put up in the most substantial manner. The external wiring is supported from square posts 8 in. $\times$ 8 in., with Wood's Flexible Adjustable Pole Brackets. By using the latter the trolley wire can be adjusted to suit the trolley pole by bringing the wire out or taking it back as the case may require, without interfering with the post. The wire is suspended about 6 feet above the rail. The poles are all on one side of track and 50 feet apart. The internal wiring is supported by the Standard mine hangers, which are fastened to cross timbers by lag screws. We find this is the best plan for hangers and fasteners, especially when the roof of the mine is friable and likely to scale off, as is generally the case where carbonate of lime is met with.

Bond Wire.—Our rail is 25 lb. "T" iron, bonded with 00 soft-drawn copper wire. The ends of the bond wires are passed through the hole in the rail which is drilled slightly smaller than the outside diameter of the cap. The cap is then placed on the wire and entered in the rail and a few blows from a hammer fasten it into place.

Generation.—The generator was built by the Westinghouse Electric Co., and is a 100-K. W. machine, 250 volts. Besides all the incandescent lights that are used along entries and side tracks, and on the tippie, boiler house, etc., this machine furnishes power for one motor, two mining machines, 1 fan 8 feet in diameter. We intend to put in another motor, and a pump in less than 30 days and to furnish power for all with the above named generator.

Engine.—The engine is a Harrisburg Standard, of 150 H. P. The engine is connected by a belt 18 inch $\times$ 18 ft. centers to generator.

Boilers.—The battery of boilers consists of two Harrisburg horizontal 100 H. P. and one Erie 60 H. P. boilers. Only the first two named are in use at present and they are not taxed to half of their capacity in generating all the steam for present needs.

Power and Boiler Houses.—These are built separate and 25 feet apart, the first is 30 $\times$ 40 ft. and latter 31 $\times$ 40 ft. Both are frame buildings and have covered sides and roof of corrugated iron.

Improvements.—The company intends to add many more dwelling houses to the number that have been already erected. Also 50 coke ovens,

and a lighting plant to light the town of Norton, in which the mines are situated. We are also adding constantly to the mine machinery and are increasing the output to meet the increasing demand for coal.

Coal Mining in New South Wales.

The Department of Mines of New South Wales has reported for 1899 as follows: The total production of coal for the year was 494,000 tons, valued at £175,715, an increase of \$5,978 tons in quantity, and £25,737 in value, over the preceding year. The contributions of the three active coal fields were:—Ipswich, 373,655 tons, valued at £127,305; Wide Bay, 111,414 tons, valued at £40,597; and Clermont, 8,940 tons, valued at £7,813. It appears that even towards the close of 1899 the colliery industry had begun to experience the consequences of the scarcity of coal in Europe, notwithstanding the great distance between the two regions. Sales of Newcastle coal had been made for shipment to destinations beyond the range of the previous demand for New South Wales coal, and from nearer markets the demand has considerably increased owing to the higher cost of delivering other coal there. Better prices were also being obtained for the colonial product, and much satisfaction is expressed by the Sydney newspapers that the threatened strike of miners had been averted. It is interesting to observe, too, that what appears to be an important discovery of coal had been made in Queensland. A report upon it says:—"Mr. B. Dunstan, an assistant geological surveyor, has just returned to Brisbane, after a visit of some months to the district in the neighborhood of the Dawson and Mackenzie rivers.

He was very successful, having found a large extent of coal-bearing country. The object of more recent work has been to determine the positions on the central railway, where bores should be put down to test the country for coal seams, as it is pretty certain that seams of coal cross the line at or west of Duaringa. Mr. Dunstan will at once prepare a report on his work, for presentation to the Minister of Mines, but this will take some time. Enquiries show that the coal in the vicinity is anthracitic, and therefore of great value. For marine purposes it is especially valuable, being high in fixed carbon, though useless for gas. The discoveries have created a vast amount of attention, and are being taken up in all directions. A Brisbane syndicate has secured a large tract of country specially favored in coal deposits. It is believed that the area of country which is coal-bearing is at least 5,000 square miles. This will give to those interested some idea of the great importance of this discovery to the Colony."



TIPPLE AND COALING CHUTES; ALSO COALING CHUTES IN THE DISTANCE.

THE GOLD COIN MINE.

A History of Its Development and a Description of the Mine, the Surface Plant and Miners Club House.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The spirit characteristic of Cripple Creek is one of expansion and growth, and no better example of this can be found than the development of the Gold Coin mine owned by the Woods Investment Co., which is one of the most enterprising companies in the district.

The Gold Coin from small beginnings developed into a great mine. In accordance with its rising dignity a magnificent plant was built over it. This unhappily was burnt, only now to be replaced by a still finer one. Nor does the money lie in the mine, from its proceed handsome offices, business blocks, and machinery

Mining Co., Robinson Victor Mines Co., The Gold Knob Mining & Townsite Co., at Gold Field, The Columbia and Victor Deep Mining and Tunnel Co., Jack Pot Mining Co., United Mines Transportation Co. All these are under the Woods Investment Co., and from these the membership is drawn.

No one can tell the boon of such an institution to miners, most of whom have no homes to go to and would otherwise spend their time in dance halls, saloons, or gambling houses.

But an enterprising spirit will not rest at home. More power and more electricity were needed by the company for the Gold Coin and other ventures than could be obtained in Cripple Creek. So the tributaries of Beaver Creek rising near the base of Pike's Peak were harnessed. A locality was found about 10 miles south of Victor, where, by a dam placed across the narrows of a cañon, a wide deep lake or reservoir of many square miles with a maximum depth of a 100 feet could be found. From this reservoir as a source of supply a big stave-pipe is being laid down one of the



THE GOLD COIN CO. LIBRARY & CLUB HOUSE
VICTOR, COL.



A MINERS CLUB ROOM.



BILLIARD
ROOM.



GYMNASIUM.

VIEWS IN CLUB HOUSE, GOLD COIN MINE.

and supply warehouses are established in the town adjacent, and last but not least, a large elegantly equipped club room for the use of the employees has been built. This cost \$50,000. The building alone \$35,000. It contains two bowling alleys, a library with tables containing all the leading mining periodicals, baths and gymnasium, games at half price, billiards, pool, etc. In connection with it is a Gold Coin brass band of 30 pieces. Ten sleeping rooms are let to club members. There is a café but no strong drink. For entrance to the club, 60 days employment at the mine of the company is required. There is a membership of 600.

Amongst those represented in the Gold Coin Club are members of the Gold Extraction Co., Teller Supply Co., Pike's Peak Power Co., Mabel M. Consolidated Mining Co., Damon Gold Mining Co., Morning Glory Mining & Leasing Co., Consolidated Gold

most precipitous and deepest cañons of the West in a notch cut in the bare face of the often perpendicular cliffs to carry water power to a power house at the bottom of the cañon 1,400 feet below.

Even to those accustomed to engineering projects this seems a most daring and hazardous undertaking. As from the little camp at Skaguay we look down over that tremendous precipice we think of Shakespeare's lines on Dover Cliff:

"Half way down the cliff hangs one that gathers samphire
—Fearful trade!"

Yet half way down the cliff a 30 inch pipe is being laid on a little ledge 120 feet below gained by blasting off down to that point whole sections of the upper part of the precipice whilst the location of the power house in the abyss looks like a mere speck

in the depths of the cañon close to the thread like river. On top of this pipe line a temporary tramway is to be made to carry materials for construction down to the end of the line. Very typical of the way they do things on a large scale is the operation to be seen at the dam in process of construction. Rock was needed for filling in and riprapping back of the steel face of the dam. A prominent granite butte looking down on the narrows of the cañon was selected, undermined by a tunnel, and blown up by one of the greatest blasts on record, the detritus supplying ample broken material for the work on hand. The dam is faced with long broad steel plates to a height of 70 feet across the narrows of the cañon.

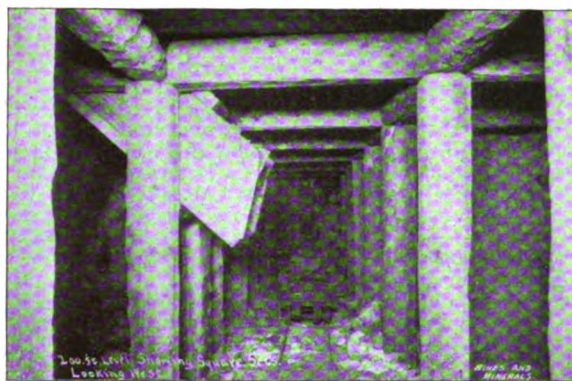
The Gold Coin mine is a peculiar one in many ways; the vein or mineralized zone occurs in the granite of Squaw Mountain, which is, so to speak, off the generally accepted mining center characterized by volcanic rocks, such as andesitic breccia and dikes of phonolite. It is just on the edge of what may have been the great volcanic crater of which one side of the granite mountain, called Squaw Mountain, may have formed a wall, as the andesitic breccia of Battle Mountain ends abruptly against it.

For a long period not much of importance had been found in the granitic Squaw Mountain, it was looked at as outside the main mineral zone, until the "shearage zone" now forming the vein of the Gold Coin mine was discovered in digging the foundations of the principal hotel of the town of Victor. This shearage-zone consisted of a zone of parallel cracks compressed close together in the granite for a width of some 6 to 10 feet and much colored by iron oxide. It was not inviting to the prospector and did not on the outcrop give any promise of the great width or riches afterwards discovered along it in the depths of the mountain. Work, however, was begun and with advance the zone became more and more mineralized with telluride and pyrite ores, and the zone itself increased greatly in size till in parts of the mine the mineralized and workable portion was over thirty feet wide.

A fine plant was erected over the mine, one of the best equipped and largest in Cripple Creek. This was destroyed in the fire that nearly demolished the little town of Victor. Besides destroying the surface plant, the fire ate its way for a considerable depth down the shaft of the mine.

As soon as the fire was over, the ground was cleared for erecting a still finer plant with the newest and most improved machinery. This is now in process of construction and erection just above the business portion of the town of Victor. A lofty smoke stack rises from above one set of boilers which are already bricked in, whilst close beside it are four great cylinders or drums with stacks of metal tubes below them for the erection of a battery of great water-tube safety boilers of the Babcock and Wilcox pattern. The two batteries of boilers are 534 horsepower each, making a total of 1,068 horsepower. The smokestack is 140 feet high, 7 feet in diameter above the cone, which at the base is 14 feet in diameter.

Powerful electric motors are on the ground, the intention being to ultimately operate the entire plant with electricity, which will be utilized to compress air for power-drilling and for operation at the



SQUARE SETTS, GOLD COIN MINE.

hoist. The electric current will be generated by waterpower upon Beaver Creek nine miles distant by the Pikes Peak Power Co.'s plant.

The hoist is a double reel hoist with cylinders 24" $\times$ 48", rated as 750 horsepower. The cable is a flat one 6 inches wide by $\frac{3}{8}$ of an inch thick. The galloos is of wood and stands up at present against the open sky 65 feet from the base. The air compressors are of the Rand pattern, cross-compound with capacity for 24 drills. The diameter of the fly wheel is 16 feet.

The dimensions of the building, according to Mr. Arthur Light, Master Mechanic, who has designed it and placed the machinery, will be as follows:

Engine house.....	65 $\times$ 53 feet.
Boiler house.....	72 $\times$ 42 feet.
Shaft house.....	49 $\times$ 40 feet.
Blacksmith shop.....	56 $\times$ 24 feet.
The height of engine room.....	18 feet.
Boiler.....	24 feet.
Shaft house.....	32 feet.

There will be two floors in the main shaft house. 72 feet will be the extreme height of the building. The brick walls will be 36 feet high, the shaft house walls will be 26 inches thick. The shaft is 1000 feet deep with three compartments each 4 $\times$ 4 $\frac{1}{2}$ feet in the clear.

The strike of the vein is approximately north and south with dip east. The dip down to the 400 feet level is 20%, from that downward it steepens to about 75 degrees.

On both sides of the shaft as we descend are big roomy stations at different levels. On the 7th level the dimensions of the station are 16 $\times$ 25 feet, on the 8th, 18 $\times$ 60 feet.

A cross-cut tunnel leads from the shaft to the vein wide enough for a double track for loaded and empty cars.

The vein or rather mineralized zone appears in the level only as a wide series, or zone, of closely compressed cleavage or rather shearage planes, cleaving the granite for a width of from 10 to 30 feet or more, the whole zone is mined right across and work only ceases at the last sign of shearage cracks in the granite or when the granite shows no more ore in its walls.

Imagine a body of massive granite, sliced nearly vertically by shearage movements into an almost schistose or slaty structure, and this zone of cracks impregnated by ore solutions, and you have the full idea of the celebrated Gold Coin vein, which has yielded, and is still yielding, its millions.

There is little quartz nor much mineral-stain, and still less apparent ore of any kind to suggest a rich vein or even a mineralized zone; occasionally a little purple fluorine stain is observed in the cracks and sometimes a rock face richly coated with sylvanite is found, and at others a "vug" or cavity between the shearage cracks, lined with quartz crystals, but this is all. The zone is oxidized down to very great depths, some free gold occurs, but most of the ore is adapted to cyaniding or chlorination. The regular average of the ore is \$46 in gold, with spots far exceeding this. For long distances as much as 30 feet of profitable ore-bearing rock is mined from wall to wall, the ore shoots being very wide. The ore or shearage



GALLOW'S FRAME AND MACHINERY IN PROCESS OF ERECTION, GOLD COIN MINE.

zone appears to be in the form of a long gigantic lens, thickest in the middle and diminishing north and south along the strike of the so called vein. The great width of the vein or zone requires the use of square sets, as many as five sets of 6 feet centers, side by side, being used across the vein and up the stopes, the square sets following the stopes right up as stoping progresses.

In some of the very wide places the square sets remind us of the excavation rather of a very wide coal seam than of a gold vein. The zone is oxidized to as great a depth as is at present reached, viz., nearly 1,000 feet.

Spurs come in in places diagonally into the main vein or zone, these which in ordinary mining are often of little width, length, or account, are here wide enough and long enough to be worked at a profit and to form an important feature in the mine. One of these spurs comes into the main body in a southeasterly direction and is 4 feet wide and has been worked for a long distance.

At the end of one of these spur drifts, they were trying a new Schmucker pneumatic-hammer air-drill. One advantage claimed for this drill was that the auger-like worm screw wrapped around the drill on withdrawal from the hole brought out all the drill dirt with it. The hammer striking the drill is inside the drill machine. The machine feed is worked by a crank.

On the 8th level in a roomy station 18 × 50 feet and 10 feet high with double track and lighted by electricity are the Snow compound pumps with capacity of 500 gallons per minute from a depth of 800 feet.

Besides the Gold Coin proper there is the tunnel of the United Mines, starting from the Gold Coin shaft, the grade for 1,200 feet is flat, then slopes 1.68 feet per 100 feet for 1,500 feet, then again for 1,100 feet there is a grade of 1.47 per 100 feet outwards to the exit. For a length of 1,200 feet a pipe 12 inches in diameter runs alongside the track for drainage to the Economic Mill, located on the opposite side of Squaw Mountain, where the tunnel opens to daylight in Arequa Gulch.

The dimensions of the tunnel are generally 6 feet wide by 9 feet high, but for 1,100 feet from the outlet the size is 12 feet wide by 9 feet high, this greater width is necessitated by a side tunnel from a vein coming diagonally in and joining the main tunnel. This side tunnel is also a transportation tunnel for properties to the north. The extreme top of the tunnel will be 10 feet high for the use of trolley cars worked by electricity. There will be 25 cars to the trip run by an electric motor.

The length of this cross-cut tunnel from the Gold Coin shaft to its mouth at the mill in Arequa Gulch is 3,774 feet. It was excavated at an average cost of \$12.00 per foot and at a rate of 175 feet per month. There is a double track as we have said for a distance of 1,200 feet from the entrance.

The object of this tunnel is drainage for the Gold Coin and other mines of Squaw Mountain, and transportation underground and at low cost of Gold Coin ore and the product of the various Wood's Investment Co.'s mines extending for a distance of nearly three miles to the north direct to the Economic Chlorination Mill in Arequa Gulch. Considering the great length of this cross-cut tunnel it is surprising how few blind or known veins or mineralized dikes were encountered in the granite of this Squaw Mountain.

Injurious Effect of Clearance in an Air Compressor.

In a recent discussion upon this subject before the Philadelphia Engineers Club Mr. Falkenau said: "I might tell of a rather peculiar experience out in Colorado, where they had a compressor running a number of drills. It failed, and after being overhauled by a certain engineer, I was called in some time afterward. They complained bitterly about the condition the compressor was in. They could not obtain the volume of air required to run one drill decently. On looking at the engine it appeared to me that the cylinder was extremely long for the throw the crank had, and I asked whether that was the original crank. The superintendent answered that it was. The engineer happened to be close by, and stated that the crank had been changed by him. It was a Clayton compressor, in which a thin layer of rubber about $\frac{1}{4}$ of an inch thick was used under the valves. Upon investigation I found that these rubbers had given out, and some bright engineer, in order to make the compressor go,—he had not time to wait for the proper rubber disks to come from New York, as it was out in Colorado,—got some rubber pump valves about $\frac{3}{4}$ or $\frac{1}{2}$ of an inch thick and put them under the inlet valves. The inlet valves are next to the piston. When the piston came up, it struck these valves; to avoid this, he put in a new and shorter crank, giving 1 $\frac{1}{2}$ inch clearance, which, of course, explained why the efficiency was so poor. I pulled out the valves, resurrected the old crank shaft, ground the valves to a metallic seat, and telegraphed for new rubbers. The metallic seat is used generally. I think Ingersoll used the metallic seat. After the rubber was inserted, of course the efficiency rose at once, and they were able to run three drills."

SULPHUR.

The Amount Consumed in the United States, Where it is Produced and the Methods of Reducing the Ores.

By Edward W. Parker.*

The amount of sulphur produced in the United States forms a very small part of the amount consumed. During the past few years more than half of the sulphur consumed in this country has been obtained from iron pyrite. The domestic production in 1899, while still small, was more than 30 per cent. larger than the combined output of 1897 and 1898, and exceeded the product in any other preceding year with the exception of 1896. Four States contributed to the product of 1899, which amounted to 4,830 short tons, valued at \$107,500. The value of the domestic product in 1899 was the largest in our history.

The localities from which the product last year was obtained were: Calcasieu Parish, Louisiana; Humboldt County, Nevada; El Paso County, Texas, and Beaver County, Utah. The principal features of interest in 1899 were the resumption of operations at Sulphur City, Louisiana, the development work prosecuted on the deposits in El Paso County, Texas, and the reopening of the old mines in Humboldt County, Nevada. Nothing was done in the way of developing the deposits reported to exist in the vicinity of Beaumont, Texas.

Including the sulphur obtained from domestic and imported pyrites the domestic consumption amounts at present to about 350,000 long tons annually, from which it can be seen that our domestic production represents about 1 per cent of the market requirements.

DOMESTIC CONSUMPTION.

The use of iron pyrite for the manufacture of sulphuric acid has during the past decade grown to be an important industry, and in considering the production and consumption of sulphur the sulphur contents of pyrite used for acid making must necessarily be included. It is only since 1891, however, that accurate statistics in regard to the importations of pyrite for acid making have been available. Prior to 1884 pyrite was included among other sulphur ores in the statistics compiled by the Bureau of Statistics of the Treasury Department. Pyrite was separately reported from 1884 to 1887, but the small quantities reported indicate that a considerable amount was imported either under the former classification as sulphur ore or as iron ore under which it was classed from 1887 to 1891, when the copper contents did not exceed 3.5 per cent. Reviewing the industry then since 1891, it is seen that in that year the amount of sulphur produced in the United States was 1,071 long tons, and the imports 117,187 long tons, a total of 118,258 long tons. The domestic production of pyrite in the same year was 106,536 long tons, and the importations 100,648 long tons, a total of 207,184 tons. Estimating the sulphur contents of both domestic and imported pyrite at 45 per cent., this total represented 93,233 long tons of sulphur, and added to the sulphur consumption makes the total for the year 211,491 long tons. This total has shown a steady and almost uniform increase until 1898, during which period there were only two years in which the sulphur imports showed a decrease (the domestic production being inconsiderable and having little influence on the total), and in each case this decrease was more than compensated for in the increased consumption of iron pyrite. In no instance had there been any decrease shown in the total pyrite consumption, any decline in domestic production being made up by larger imports, and vice versa. In 1898, notwithstanding the war between the United States and Spain, and sulphur contraband of war, the imports of sulphur into the United States showed an increase of 16 per cent. This was probably due to the increased demand for sulphur as one of the ingredients in powder manufacture, for which the sulphur contents of pyrite are not so readily available. The consumption of pyrite also showed an increase, all of which was made up of the domestic product, as there was a slight decrease in the imports. The total consumption in 1898 amounted to 366,337 long tons, of which 165,575 long tons were of sulphur and 200,762 long tons the sulphur contents of pyrite. The increase in the consumption of sulphur itself in 1898 as compared with 1891 was 47,316 long tons, or 40 per cent., while the amount of sulphur contained in iron pyrite consumed in 1898 was more than double that of 1891. The statistics for 1899 show that the imports of sulphur fell off approximately 23,000 long tons to 141,533 long tons, which was about the average amount imported in 1896 and 1897, indicating a lessened demand as a result of the close of the war with Spain. The production of iron pyrite in the United States also decreased, the sulphur contents of the product in 1899 (based upon 45 per cent. sulphur) being 8,384 long tons less than that of the preceding year. This

* Extract from the Annual Report of the U. S. Geological Survey, Vol. XXI.

loss was nearly made up by an increase in the imports of iron pyrite, of which increase the sulphur contents were 7,693 long tons, 691 tons less than the decrease in the sulphur contents of domestic pyrite. The net decrease in the domestic consumption of sulphur from all sources in 1899 amounted to 20,433 long tons. It is the first time in eight years that the consumption has shown a decrease, and, as stated before, the decrease was probably due to the unusual demand in 1898.

THE SICILIAN SULPHUR INDUSTRY.

The island of Sicily, off the southern coast of Italy, furnishes the greater part of the world's supply of sulphur. For the past three years the industry has been largely controlled by the Anglo-Sicilian Sulphur Company, Limited, whose operations cover at least 70 per cent. of the output. The syndicate has been able to keep the business fairly well in hand notwithstanding the rather unsatisfactory methods pursued by the independent producers, whose chief aim seems to be to get out all the sulphur possible without reference to the condition of the market or the immediate demand. According to the British consular report, the laws and provisions of the mining leases are chiefly responsible for the unsatisfactory conditions. A lease is usually made for ten years, during which time the leaseholder expects, and is expected by the landowner, to push the production as rapidly as possible and to pay his landlord 20 per cent. royalty. At the end of the ten-year lease the landlord takes back the mine. In spite of having to contend with these conditions the operations of the syndicate appear to have been conducted satisfactorily, not only to the producers and refiners at Catania, but to the stockholders in dividends.

It is reported that during 1899 production was in excess of the market requirements to such an extent that the surplus carried over at the end of the year exceeded the stocks carried a year before by 100,000 tons. Much of this was doubtless due to the curtailed demand from the United States. This country takes about 30 per cent. of the annual shipments, and any marked falling off in the demand from the United States is quickly felt at the producing point. The requirements of the paper manufacturers, who now consume large quantities of sulphur, will probably continue to increase.

REDUCTION OF SULPHUR ORE IN SICILY.

In response to a request from the State Department, the United States consuls at Catania and Palermo have furnished the following descriptions of the methods in vogue in and near those cities for the reduction of sulphur ore:

Catania.—There are four different methods employed in Catania for the fusion of sulphur ore, known, respectively, as the calcarone, Gill, Flocchi, and Orlando systems.

The first, the calcarone, is the primitive mode of extraction, and is the one generally used. The kiln is built into the ground to a depth of 6 to 9 feet, the walls being of masonry and cylindrical in form, with a sloping floor of stone and gypsum. When the calcarone, or kiln, is filled, the ore at the bottom is in large pieces, so that there may be no impediment to the "olid" (Sicilian term for molten sulphur) running out, and the pieces of ore become gradually smaller until the top of the calcarone is reached. The ore is then heaped up in the form of a large cone, and is covered with turf, sand, and refuse from former fusions, to prevent loss and to protect it somewhat from the elements. During the filling process several air shafts are placed in the ore, by means of which the fire is communicated thereto, and through combustion of the mineral itself the whole mass melts, this process lasting from ten to twenty days. A small hole is made at the lowest point of the wall, through which the liquefied sulphur runs and is taken off into square wooden forms, containing from 130 to 170 pounds of sulphur. This is continued day by day until all the sulphur is extracted. The capacity of the kilns varies from 7,000 to 52,500 cubic feet, and one fusion of a large calcarone lasts three months. One great disadvantage of this system is the danger to vegetation by sulphur fumes. The calcarone is allowed by law to be in operation only from June 28 to December 31.

The second system, known as the "Gill," is by furnaces or ovens built in masonry similar in form to the calcarone, but much smaller and covered with a cupola of masonry. They are generally built and worked in pairs, and each cell or oven contains from 5 to 30 cubic meters (177 to 1,059 cubic feet) of ore. They are, however, also built in batteries of four, and the system is this: After being charged the ore in one cell is fired and the smoke, instead of passing into the open air, as is the case with the calcarone, passes into the adjacent cell and gradually heats the mineral, until by the time the first cell has finished working the other has reached such a temperature that the ore ignites and cell No. 1 is again filled; and so the process goes on. The advantage is that the gases, which are heavily charged with sulphur, are not lost, and the percentage of sulphur

recovered is considerably higher; further, the time occupied is much less than with the calcarone, the working of each cell occupying from seventy-two to ninety-six hours, according to size, and as very little smoke escapes, the proprietors can work all through the year.

The next system, known as the "Flocchi" patent, consists of wrought-iron cylindrical receptacles, which are suspended by circular flanges and have an inner perforated shell. When the apparatus is ready to be filled with ore it is placed in a vertical position, and the ore, before being put in, is broken into small pieces; when filled, the apparatus is turned in a horizontal position and a steam pipe is screwed on. Steam at from 60 to 80 pounds pressure is then turned on, passing into the space between the outer and inner shell and to the mineral through the perforations of the inner shell, and in this way reaching all parts of the ore. As the mass of ore is heated the steam becomes dry and the sulphur fuses and is run off into proper receptacles.

The apparatus is 4 meters long by 1.20 meters in diameter. Three are worked in a row, each containing 3 cubic meters of ore, and seven fusions are made in twenty-four hours. A steam boiler of 16 horsepower is required for the necessary steam. This system is adapted for rich ore or ore that is porous; very hard ore cannot be fused. The percentage of sulphur recovered is much greater than with the calcarone method, with the added advantage that the sulphur ore can be rapidly turned into commercial sulphur. The cost of a plant of this kind being rather heavy, the smaller mine owners prefer the old calcarone system.

The last is the Orlando system, and is the same as the Flocchi, except that the apparatus always remains horizontal. Four trains, each loaded with about 15 hundredweight of ore, are run in on rails and remain during the fusion. The advantage over the Flocchi system is the greater facility in charging and discharging the apparatus.

All the refining of sulphur, with the exception of one plant at Palermo, is done at Catania. The largest plant consists of four ovens, each containing a battery of ten retorts for refining, capable of turning out 48 tons of refined sulphur in twenty-four hours; four ovens with four chambers for subliming and making flowers of sulphur, capable of producing 2,000 tons during a season, and a steam mill with runner edge stones of lava, capable of milling 3,000 half-hundredweight bags (165,000 pounds) of sulphur a day.

The refining season commences in October and ends in June. The milling season lasts only about four months—say from February to June—and the product is used almost exclusively for the sulphuring of vines. In refining sulphur a large oven in masonry is used, with an arched roof, upon which are placed the cast-iron retorts, which are again covered by another arch, upon which are placed cast-iron boxes surrounded by brickwork. Newcastle coal, mixed with wood in order to obtain an abundance of flame, is used. The fire grate is at the bottom of the oven, and the gases and flame ascend by spiral openings and play around the retorts, and the smoke rises by the flues to the cast-iron boxes and thence to the chimney or stack. The sulphur is put into the cast-iron boxes, where it is fused, and by means of a valve it passes into the retorts, where it is transformed into gas, and from there, by a special cast-iron pipe, it passes into the condensers, which are cylindrical cast-iron vessels. The refined sulphur, which has again become liquid, then passes by a special aperture into cast-iron pans, so that it may gain the required temperature, and is then ladled out into cast-iron forms of about 1 hundredweight (110 pounds) capacity; or, if rolled sulphur is required, it is ladled into metallic molds of the shape usually employed in commerce.

In subliming sulphur an oven, as described above for refining, is used, but with only two retorts, and the gases, instead of going into the condensers, ascend into a large, specially constructed chamber, lined with bricks, which is hermetically closed with the exception of a valve in the roof, which opens automatically when the tension produced by the gases is too great for the strength of the chamber. The gases, as they enter the chamber at the necessary temperature, solidify, and the sublimed sulphur falls in the form of flakes, like snow, to the ground.

The sulphur of commerce contains from 2 to 5 per cent. of impurities. The lower, dark-colored qualities—such as good or current thirds—are generally used for refining, owing to their lower price.

The total export of sulphur from Catania from January 1 to December 1, 1898, was 415,424 tons, of which the United States received 131,678 tons; France, 84,369 tons, and Germany, 26,727.

PALERMO.

There are at the present time three methods of reducing sulphur ore in this district, viz., the calcinatory furnace ("calcarone"), the Gill oven, and the steam process.

By the first two methods the fuel used is sulphur in its

mineral state, and by the third pit coal. Reduction by calcinatory furnace is the more general method in use, as the furnace is easy of construction and involves little expense, being operated in the open air and capable of smelting several thousands of tons of ore at a time. The calcarone is located as near the mouth of the shaft or mine as possible, usually on the side of a hill, so that, when the process of smelting is complete, the sulphur may run down the hill in channels prepared for that purpose, part of the sulphur being burned in the process of smelting, in order to liquefy the remainder.

The calcarone is circular in shape, and has a floor with an inclination of from 12 to 18 degrees. The wall around it is made of rough stone cemented with mortar of gypsum. At the back of the wall the thickness is some 45 centimeters, increasing to the front, where it is 1 meter or more, according to the diameter.

In the front is an opening, 1.30 meters high by some 30 centimeters broad (51 by 12 inches), through which the melted sulphur flows. Two walls run at right angles with the circular wall upon each side of this opening, 80 centimeters in thickness, with a roof over them to strengthen the front of the kiln. The stone floor of the kiln is covered with the refuse of a former smelting, called "ginese." The stonework is from 15 to 25 centimeters (6 to 9.3 inches) in thickness, and the covering of ginese is some 20 centimeters in depth, this increasing at the lower extremity. The inner side of the wall is covered with a mortar of gypsum. The capacity of these calcarones varies from 100 to 1,000 tons. It requires thirty days to run off a calcarone of a capacity of 300 tons; sixty days for a capacity of 1,000 tons.

The cost of a calcarone with a capacity of 1,000 tons is 1,500 lire, or about \$300 in United States currency.

In filling the calcarone the larger blocks of ore are placed in the center, forming, as it were, the backbone of the pile, the remaining space being filled with ore much smaller in size. When the calcarone is filled with ore and covered with ginese, the shape or form of the pile is that of a cone, and after being set on fire it resembles a small volcano. As the liquid sulphur comes from the calcarone, it flows into wooden molds, forming solid blocks, weighing about 100 pounds each.

The quantity of sulphur produced by this system during the years 1890, 1891, 1892, 1893, and 1894, compared with the total production of the mines operated, shows the following proportions: 80 per cent., 71 per cent., 65 per cent., 66 per cent., and 62 per cent., respectively.

At the present time about 20 per cent of the total production of sulphur in Sicily is reduced by the "Gill" system. Originally this system consisted of but two rooms or cells, but at the present time four cells are built together. These have usually from 10 to 50 cubic meters capacity. While the percentage of sulphur obtained by this system is greater than by the calcinatory furnace, the quality is said to be inferior. These ovens being built of solid stone masonry, it is claimed that much heat is saved and again utilized by this system of reduction. One cell only being fired at a time, the ore in the others becomes dried out, and is in a much better condition to burn freely when fired, thus saving both time and fuel. The floors of these cells are constructed upon the same principle and of the same material as those of the calcinatory furnace.

Reduction of sulphur ore by steam covers only about 10 per cent. of the production of the mines in Sicily. The boilers or "cookers" in use are of various kinds and forms, some being movable, while others are stationary. In those of a cylindrical shape the ore is placed in a capsule of perforated iron plate inside the boiler. By the more general method the ore is reduced in small wagons having perforated bottoms and sides, the steam being conducted through iron pipes. Only a certain quality of the sulphur ore of Sicily—a very small percentage of the production—yields to steam process, and for this reason it is not probable that the reduction of sulphur by steam, as at present utilized, will become general. By the calcinatory furnace and the Gill system, the fuel used being the crude sulphur, the cost is trifling, while fuel for steam reduction has to be shipped into the country at a great expense.

The system of reduction by the calcinatory furnace is the oldest known to the sulphur producer of Sicily. It is said to have been the original method employed at these mines centuries ago. Being simple in construction, furnishing its own fuel, and requiring little skill to operate, it bids fair to remain the favorite method.

Mining an Underground Forest.

The working of a mine the product of which is timber, is an operation not to be seen every day, but a noteworthy mine of this sort is to be seen in Tongking, where, in a formation of sand, at a depth of from 14 to 20 feet, a deposit, tolerably thick, of the stems of trees, which thousands of years ago must have existed as

an extensive forest, but eventually became buried by an earthquake or other similar phenomenon, has been opened and is now being mined through gangways. The timber in no way forms any kind of coal, but is in good condition, a fact to be attributed to the large proportion of resin which it contains, and to the sandy nature of the ground in which it lies. The Chinese work the mine methodically, and use the timber chiefly for sculptural purposes, coffins, troughs, &c. The stems have a diameter of a yard, are 45 feet long and appear to be a kind of fir very similar to pitch pine.—*Maritime Mining Record*.

Manganese Mining in Cuba.

Mr. Eduardo J. Chibas, C. E., in a report dated 1899, on the Ponupo manganese mines, states that the mines of this group, the Vencedora, Sultana, Balcanee, Inca, Generala, and Mascota, are located at the terminal of the Ponupo branch of the Sabanilla and Maroto Railroad, both the railroad and the mines being controlled by the Ponupo Mining and Transportation Company. The main line of the Sabanilla and Maroto Railroad extends from Santiago de Cuba through Cristo to San Luis, in the province of Santiago de Cuba, a distance of 20½ miles. Just above Cristo station (11½ miles from Santiago) a branch goes to Ponupo, making the total distance from the mines to Santiago 22½ miles.

The Ponupo manganese deposits are located on the tops and flanks of small hills that branch out from the Sierra Maestra range of mountains, the hill on which the Vencedora deposit is located rising 240 feet above its foot, around part of which flows the Ponupo River.

The rocks in the neighborhood of the deposit are much decomposed, with the exception of some boulders of porphyry and the jasper which comes associated with the ore, and this and the thick vegetation make it difficult to determine the exact geological formation.

At the Ponupo mines it is probable that the manganese may have been derived from one of the igneous rocks, where it is often present in the form of silicate. This was chemically decomposed when the rocks began to disintegrate by the action of atmospheric agencies, and the manganese was carried in solution in the surface waters, and when aided by favorable conditions was deposited in the form of oxide. The deposition of the ore was governed by local conditions, and consequently the extent and continuity of the deposits have to be investigated in each particular case.

The ore is found in pockets of greater or less extent, embedded in clay, resulting from the decomposition of the original enclosing rock. This clay in places assumes various shades of color—red, white, and yellow—due to the different stages of oxidation of the iron and manganese it contains. The ore is also found associated with red or yellow jasper.

The Vencedora claim is the only one worked and all the ore shipped has come from four open cuts. The portion developed in cut No. 1 presents a face 7 feet high and about 200 feet long. It rests on clay and is capped by 3 to 5 feet of soil and jasper. The ore is easily mined with pick and shovel, no blasting being required. The pocket of ore does not lie horizontally, but follows more or less the rise and fall of the ground. The ore is generally of uniform quality and does not require washing. Most of the ore shipped was mined in this cut.

Cut No. 2 is 80 feet long, 15 feet wide at the bottom, and 18 feet deep at the deepest portion. On the eastern wall and along the whole length of the cut is a 5-foot layer of wash ore resting on clay. The western wall shows no marketable ore; it is composed of clay, rock, and highly silicious ore. The south end of the cut presents a face 18 feet high, which is the whole depth of the cut, and about 10 feet wide. The capping covering the ore around this cut consists of a few inches of soil.

The southern wall of cut No. 3 shows wash ore near the surface and for a depth varying from 3 to 5 feet. On the western wall is a capping of about 3 feet of clay and dirt and 5 feet of manganese ore of light weight. In this cut some boulders of porphyry are found.

The number of men employed is about 80, the wages being 75 cents a day. The cost of mining the ore is estimated at \$1.50 to \$2 per ton, and the royalty is 85 cents per ton.

Freight from Ponupo to Santiago is \$1.60 per ton. When the vessel which is to transport the ore is in port the cars are run alongside the boat and the ore is carried into the hold in buckets. When the vessel is not in port, the ore is piled on the ground in Santiago, and on the arrival of the ship is again loaded and taken alongside.

The Sultana mine is located east of the Vencedora. Ten test pits, most of which show good ore, have been sunk, but no working is carried on. The eastern bank of the Ponupo River is very steep and towers about 100 feet above the river, showing along its face here and there for about 200 feet outcrops of manganese ore, some of which are of good quality.

BUFFALO HUMP, IDAHO.

Facts About a Mining Region Which Is Attracting Great Attention and Which Promises Well.

Written for MINES AND MINERALS by D. G. Doubleday.

There is probably no other new mining region in America attracting more attention at the present time than the Buffalo Hump country of Idaho, and when the factors of area and the universal distribution of rich quartz deposits are considered it can be reasonably said that there are few mineral districts in the world presenting greater possibilities. Figuratively speaking, the development of this mineral zone has just commenced, and the work so far prosecuted, small as it is, considered from the standpoint of production, gives abundant assurance of great things.

The name "Buffalo Hump District" was originally applied to a limited area surrounding the mountain itself, but the significance of the term is fast becoming more comprehensive and is now intelligently used as designating that entire portion of Idaho in which the geological formation is identical with that of the original Buffalo Hump district. This enlarged significance of the name is due to the gradually widening circle of exploration and discovery. The area of the Buffalo Hump country of today is about 10,000 square miles, but this should not be interpreted as comprehending the entire mineral zone; the ablest geologists are now including the whole of central and southern Idaho south of the Panhandle in the gold bearing zone, and the discoveries of the past year made throughout this vast area give a valid foundation for the belief of experts.

Comprehended as a whole in this larger sense, the Buffalo Hump country includes all that portion of the State covered by the Bitter Root mountain ranges and their spurs, extending to the ridges bordering the Polouse Valley on the west. To approximate the area of this immense tract would signify but little; suffice it to say that it is only during the past two years prospectors have been traversing this labyrinth of hills and mountains and there are still thousands of square miles upon which the white man never set foot.

The Buffalo Hump mountain, itself, is one of the historical landmarks of south-central Idaho and for many years has been the sentinel by which the adventurous placer miners and trappers have worked their way to old camps of Florence, Dixie, Elk City and the fur grounds of the higher mountains beyond. The high upheaval rises to a height of 8,870 feet above sea level and at the outside base of its foothills has a circumference of 200 miles. The placer camps above referred to, all thriving towns in the early 60's, lie among the foot hills surrounding this mountain. The outline of the summit resembles the back of a charging buffalo, hence the name.

Looking back through the past ages the imagination pictures all these innumerable flat topped mountains of the Hump country with sharp peaks, apparently distributed according to no definite plan. Then came the glacial epoch and the immense volume of ice and snow ground down these pointed peaks, cut them off, and dropped the debris into the valleys and basins. There is no question as to the origin of the rich placer deposits discovered in this region; they are directly attributable to the grinding irresistibility of the glaciers upon the rich quartz deposits of the mountain tops. Through the course of time the natural action of water upon the quartz debris, dropped and tumbled into the valleys, congregated the fine particles of gold into the form of placer nuggets. The millions taken from the camps at Florence, Dixie, and Elk City are indicative of the richness of the quartz leads in the higher altitudes, the original depositories of the placer gold. Quartz float is everywhere; the sides of the mountains, the valleys, water basins and streams are strewn with the characteristic quartz, and gold can be panned from almost every particular piece. It is this universal distribution of rich float that first amazes the traveler. Along the streams he sees the accumulation from the old placer workings; he follows the winding water routes circling the mountains and finds their bottoms covered with quartz—the evidence of vast mineral wealth is scattered universally over the district. The action of the glaciers has left the solid rock foundation exposed to a large extent and the huge outcroppings of quartz are easily discovered in the exposed areas; the leads are strong, solid and permanent fissures. The drift material seldom exceeds 15 ft. in depth anywhere.

In the old placer ground near Elk City the visitor is told that \$40,000,000 was taken from 20 acres of ground in five weeks; the neighboring mountains satisfy his curiosity as to

where the gold came from. The writer saw five quartz fissures on one of these mountains, their width averaging over 12 feet. Seaming the slope was a narrow streak of crystalline quartz especially worthy of remark. It had a width of about 6 inches and could be traced on the surface for 80 feet. A depth of 14 feet has been made in working assessments and the owner, sitting in this 14 foot hole with his pestle and mortar, pounds out enough gold in a half a day to have a two weeks' continuous carousal. Hundreds of these large quartz leads are now being developed in the immediate vicinity of the Hump and it is no exaggeration to say that a thousand are being worked within the limits of the known mineral zone. A number of the larger companies hold from 40 to 80 locations, work being done upon all of them.

Work on the Big Buffalo is being continued upon the same large scale it was inaugurated and development so far prosecuted seems to have verified and sustained the hopes and expectations of the promoters. Mining men of this district are watching the development of this property with considerable interest



MOUNTAINS IN BUFFALO HUMP REGION.

as they believe the ultimate results on the Big Buffalo will, in a great measure, have a direct influence upon the development of the entire district. A shaft 200 feet in depth with drifts both ways on the vein aggregating as many more feet represents approximately the work underground and reflects the energy and push of the managers. Recent developments on the property have made it necessary for the management to consider the installation of a smelting plant the nature of the ore requiring the smelting process. Whether the company will establish a plant or ship to a smelter now in operation cannot now be stated. There is probably no other mining location in the west which has presented more difficulty in accessibility than the Big Buffalo, Clark and Sweeny have emphasized their faith in the district and in the Big Buffalo in particular by the broad lines upon which they are operating.

Transportation facilities have been secured at a tremendous cost; freight and supplies for the mill and camp have been taken to the property under conditions that for problems presented have few parallels in mining operations. No problems are now to be met which have not already been partially overcome; the mine is now a producer and everything is upon the property to continue as one.

The shaft is equipped with a large hoist and an adequate drill compressor plant. A stamp mill of ten stamps is now in operation. The company intends utilizing a splendid waterpower conveniently situated to the mine, the machinery of the plant to be ultimately driven by electric motors. Over seventy tons of machinery is now consigned to the location and will be freighted in this winter. A town of seven hundred people, mostly employed by the company, has been built the past summer and the top of the Buffalo Hump is fast becoming the site of a thriving mining town.

The company ranking second in the way of devel-



PLACER MINING IN BUFFALO HUMP REGION.

of 25 feet. On the St. Louis some 200 feet of development has been done on a fine body of quartz. Values on these locations run from \$16 to \$20.

The Buffalo Hump Development Company is developing the "Fortune." Three hundred feet of work has been done and wherever touched the vein has carried values of good promise. Norman & Cameron of Spokane head the company and manifest their faith in the district by the large number of locations which they control.

A location called the "Dewey," worked by Russ Davidson and others gives good promise from present developments. The lead is a magnificent deposit of quartz characteristic of the district and considerable free gold is found in the lead.

The "Jumbo," worked by Frank Brown of Grangeville has a 250 feet of development in tunnels with pay ore in every foot. Something like \$200,000 worth of ore is now in sight in this property.

The "Cracker Jack" and "Santa Rosa" lie parallel with the Vesuvius, a property held by Clark and Sweeny, the former two being worked by Rufus Halley of Santa Rosa, California, and Claude Flint of Grangeville; some 300 feet of development has been done on the lead, and values approximating \$20 are found.

A parallel vein is also owned by the same party and a cross-



CHARACTERISTIC SCENERY, BUFFALO HUMP REGION.

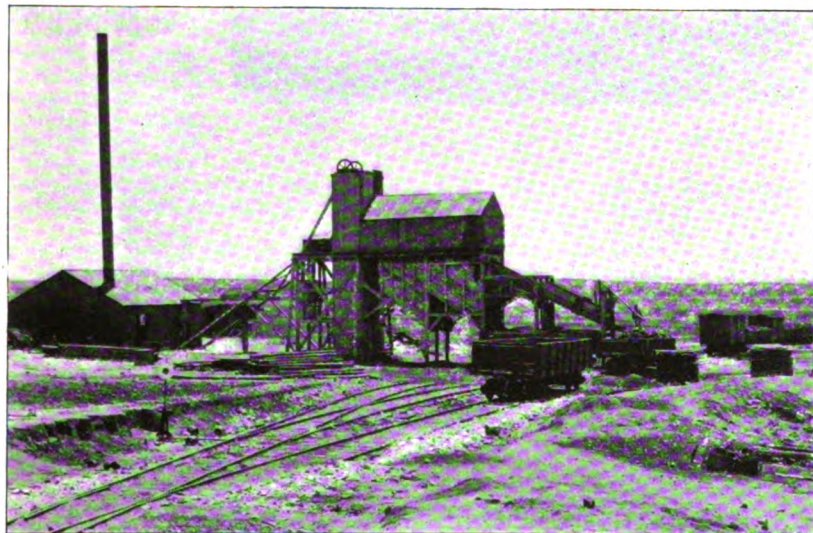
cut tunnel is now being run to cut it at considerable depth; the vein is 15 feet in average width.

The "Winslow" is another one of the huge leads of the camp, and it is situated parallel to and adjoining the Vesuvius; the ledge is strong, well defined with the characteristic quartz carrying high values in free gold and concentrates; the width of this vein is 25 feet. Ruby silver assaying 1,000 oz. to the ton has been found in this vein. The location is owned by Albert Allen and E. J. Roberts of Spokane and Edward Highsman of Mt. Idaho, Montana.

In the southern part of the camp there are several good properties, and among them are the "San Francisco" and "Mother Lode" having quartz veins over 25 feet in width.

The "Buffalo Hump Broad Water Consolidated Mining Co." owns the northern extension of the Vesuvius. Considerable development work has been done and a large body of mineralized quartz uncovered.

All of these larger companies now have control of from one to one hundred claims and work carrying out the statute provisions relative to assessments is being done upon all of them, while on the most favorable looking crews are employed. The individual claims being worked are so numerous as to preclude mentioning in an article of this kind. In and about Elk City the Algonkian Co. is operating, and now holds from 15 to 25 fairly good locations. The Gold King Group of nine claims



SURFACE WORKS, CURTIS COAL CO.

has some splendid leads with an average assay in one of the properties of \$24. The Gold King claim itself, the original claim of the group, has a vein over 15 feet in width. There are other properties in this district in close vicinity to Elk City which give great promise.

At Dixie, 25 miles from the Big Buffalo, four big discoveries have recently been made, and upon the property handled by P. R. Hogan of West Superior, Wisconsin, and William Hogan of Helena, Montana, it is claimed that there is enough ore now in sight to warrant the installation of a stamp mill. This company is doing considerable development work and in a mill test of some 500 pounds of rock, values of \$171 to the ton were found. The quartz from this location is exceedingly rich in free gold, and at a depth of 80 feet the same values still continue in the vein.

During the past year some \$50,000 has been spent in improving the road from Stewart to Elk City, and Clark and Sweeny have been responsible for the cutting of a new road 12 miles in length over the rocky surface of the Big Buffalo.

That a railroad will eventually be built into this district by the Northern Pacific people is one of the near possibilities; and the road will in all probability be extended from the present terminus of the Spokane, Lewiston branch.

Mining men of authority who are interested in the district state that the Northern Pacific people are only waiting for definite results from the Big Buffalo development before extending this branch of their system. A survey has already been made from Stuart, the present terminus, to Elk City. From the present operations of the companies interested in the Buffalo Hump District it looks as though next summer will see more active development on locations in this district than in any other new mining region of the country.

THE CURTIS COAL MINE.

Description of a Valuable Lignite Deposit Near Colorado Springs, Colorado.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

Some little time ago we published in MINES AND MINERALS an account of a newly opened coal field, close to Colorado Springs, known as the El Paso coal field.

Though coal for many years had been known to exist about five miles north of Colorado Springs, the seams on their outcrop appeared so narrow that little development was done. Within the past year or two a shaft was put down and within a hundred feet of the surface a fine seam of superior lignite coal was found nine feet thick. This was about four miles north of Colorado Springs.

It appeared to us then that if borings were put down, the field might be found to extend still nearer the city limits. This experiment has been tried and has resulted, at the Curtis Mine, in finding at a depth of 85 feet a horizontal seam of first-class lignite coal from 17 to 24 feet in thickness. It is a remarkably pure seam without clay partings or admixtures of bone or other visible impurities. It is the largest seam of this class of coal yet found in Colorado along the Eastern foot-hills of the Rocky Mountains.

These seams rarely average more than six feet in thickness and the greatest, we believe, is one at La Fayette twelve feet thick, of soft coal.

The analysis of the Curtis coal shows it to be above the average of our so-called "lignitic" coals, as follows:

Moisture	21.6%
Volatile matter	32.5%
Fixed carbon	41 %
Ash	4.9%

The ash is very low while the fixed carbon is high for coals of this class. The analysis indicates that it should be an excellent domestic coal, and also well adapted for ordinary manufacturing purposes. Coals of this class do not however make good coke.

There is a slight dip of the coal from the horizontal of $4\frac{1}{2}$ degrees and to the northeast. It is mined by shaft and by two principal entries crossing the dip transversely. The roof and floor are of bone and clay, and there is a little water in the mine.

The mine could, if called upon, produce an output of 1,000 tons per day, but the present capacity is limited to 500 tons daily. This mine lies between two parallel railroads, the Rock Island and the Santa Fé, and within less than a mile of each. It is barely out of the city limits, at the foot of Austin Bluffs. So fine a body of coal, so

near an important town like Colorado Springs has its value despite its having to contend with the bituminous coal and Cañon City coal, brought up from the South.

Within a few yards of the mine a large electric power plant is being constructed for lighting, motive power and other purposes, for Colorado Springs and Colorado City. This will use the Curtis coal.

The various large metallurgical works lately constructed near Colorado Springs will doubtless also use this coal and large consignments of it, as well as of its fine slack coal, are shipped, we understand, to Cripple Creek and used in the electrical and other works there. The retail price, we understand, is three dollars per ton in lump, and \$2.60 nut size, for domestic use locally.

The Rate of Wages Paid to New South Wales Miners.

At present miners in Sydney are paid a hewing rate of 76 cts. per ton, which is based upon a selling price of \$1.96 per ton. This rate rises or falls 8 cts. per ton with every rise or fall of 24 cts. per ton in the selling price of the coal. The miners have asked that the selling price be put up to \$2.04 per ton for the remainder of this year, which would increase their rate by 4 cts. per ton, bringing it from 76 cts. per ton to 80 cts. The miners, in making this demand, did so on the understanding that a further advance of at least 24 cts. per ton would be made at the beginning of the year, by which time this year's contracts will have expired. In reply to this the proprietors said they could not agree to an increase during 1900, as the selling price was based upon contracts already in existence. But they propose to put up the selling price at the commencement of 1901 from \$1.92 to \$2.40 per ton, which would mean an advance in the hewing rate of 16 cts., or an increase from 76 cts. to 92 cts. per ton.

CYANIDING STAMP MILL TAILINGS

In Western America—A Description of the Dexter Gold Mining Company's Plant at Tuscarora, Nevada.

Written for MINES AND MINERALS, by Wm. Magenau.

The great success attending the application of the cyanide process to the treatment of stamp-mill tailings is well indicated by the matter-of-course way in which non-technical mining men are coming to regard the cyaniding annex of the stamp mill as much a part of the free-milling equipment as the amalgamated plates or concentrating machines.

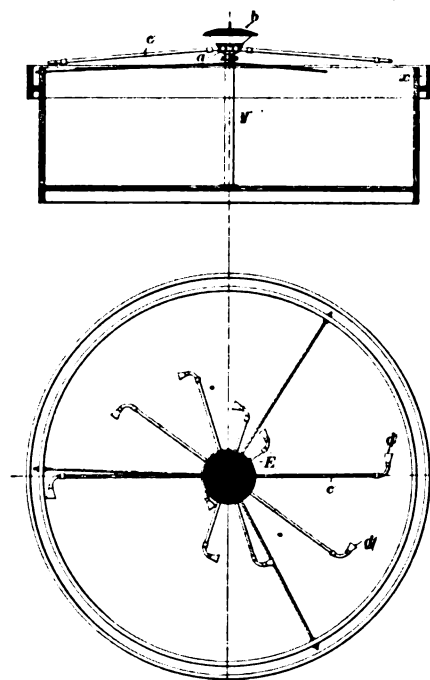
Following the tremendous large-scale successes of the past ten years in South Africa, Australia and New Zealand, many American mills gave attention to making additional savings from the material passing from plates and vanners, while dozens of comparatively small propositions which could not yield a profit by free milling alone were put on a paying basis by the combination treatment. The way having been shown by numerous small enterprises, the large operators in America are now installing plants of a size and completeness approaching the scale of South African achievements. The Homestake Company in South Dakota has nearly completed a 1,200 ton-a-day plant; the Cochite Mining Co. in New Mexico possesses a similar equipment; the Golden Cross in Southern California recently built a very large plant;

the Bessie, at Telluride, Colorado, is well equipped, and many others are following.

The difficulties to be overcome in handling stamp-mill tailings in a cyanide plant are nearly always principally mechanical. The stamp-mill treatment is an excellent preliminary, removing as it does any soluble acidity in the ore by the copious washing applied, and when concentrating machines are used, removing the very ingredients which are most apt to be objectionable in cyaniding, but even under these favorable conditions complications are apt to be met with which require the services of a chemist to avoid, and it is the policy of the best managed enterprises to have a well-trained metallurgist in charge until any

chemical problems have been solved and a routine has been established which gives the best results, when the plant may be turned over to a foreman fitted to give alert attention to mechanical details. A description of what may be called a typical western plant, yet possessing some novel features, coming within the writer's recent experience and observation, may be of interest. This plant is located at Tuscarora, in Elko County, Nevada, and belongs to the Dexter Gold Mining Co., of Salt Lake City, Utah.

The plant treats tailings from a forty-stamp mill, crushing in the past few months an average of 102 tons daily. The ore is silicious, carrying upwards of 85% silica and about 10% iron. The richer ore occurring in narrow seams in the country rock, carries much clayey material, necessitating the use of very large amounts of water in the stamp batteries, the quantity being about 5 gallons per stamp per minute. From the amalgamated plates the tailings run directly to a bucket elevator. Formerly the spiral sand-pump manufactured by Frenier & Sons was used for elevating the tailings, but its capacity for volume was insufficient for the exceptional amount of water required. A narrow launder carries the tailings from the top of elevator a distance of some 200 yards to the "settlers" in the cyanide plant. These settlers, which are designed to separate the sands from the slimes in the tailings, are three in number and consist of round iron tanks 12 feet deep and 18 feet in diameter. Each is supplied with a Butters and Mein automatic revolving distributor, a most excellent appliance first used in South Africa some seven years ago.



BUTTERS & MEIN'S AUTOMATIC DISTRIBUTER.

It consists of a number of radiating 2-inch pipes of various lengths, centering in an inverted-cone-shaped receiver mounted on suitable bearings at the center of the tank, the bearings being supported on timbers across the top of tank. The stream of tailings being discharged into the receiver finds outlet through the radiating pipes, each of which is bent to a right angle a few inches from the end. The reaction of the discharge from the pipes causes the whole appliance to revolve, distributing the material uniformly over the tank which is supposed to be first filled with water. In the correctly designed plant, the overflow from the tank, carrying with it the slimy portion of the tailings, goes into an annular trough, thus giving the largest possible cross-section to the out-flowing stream and carrying out the least possible quantity of sand. At the plant under discussion the settlers were built with a discharge at one point about 18 inches wide, apparently as a supposed economy in construction, but quite unjustifiable from any other point of view. The settler bottoms are provided with simple gravel filters, and two 18-inch discharge holes fitted with hollow cylindrical plugs of light sheet iron, these being made in sections of 4 feet each.

The three settlers are built upon timber framing 5½ feet above the ground, the foundation for this being wooden sills 2 in. × 12 in. laid on 6 inches of concrete, the ground here being somewhat soft.

Tracks are laid under the tanks. When running regularly one of the settlers is filling while the second is draining and the third is being emptied. This latter is done by shoveling through the discharge holes into cars beneath. Draining is accomplished through a vertical box 10 inches × 4 inches × 12 feet, running up the inside of the tank, and having one of its broad sides made of old battery screens. There are also 4 drain-pipes distributed about the bottom which assist materially. Better results are had in leaching when the water has been well drained out, so these arrangements are important, and it is always well to have ample settlers to allow sufficient time for this operation.

It is very desirable in operating these settlers to have provisions for replacing the stream of tailings by water alone when for any reason the former is cut off for a time. At this plant this is impracticable as the tailings elevator is driven from the stamp-mill shafting and hence is inoperative when the mill shuts down. Under these conditions the effect of even a short stoppage is to allow the settlement of a layer of slimes with the sands and subsequent drainage is materially prolonged.

The settlers, as operated at the Dexter mine, catch 51% of the material fed into them, the slimes being conducted into ponds banked up near the cyanide plant. Their subsequent treatment will be discussed later.

The cyanide plant is supplied with about 52 tons of sands daily. A settler having been filled and drained, its contents are shoveled into cars beneath as described, and trammed into the adjoining leaching department. This is equipped with 14 tanks, 10 of these having a 20-ton capacity and 4 a 50 ton, making a total tankage of 400 tons. This suffices for a 5-days leach with the daily tonnage stated, a time found to give the maximum average extraction, though very often results are equally good in two or three days, especially in gold. The smaller tanks are round with wooden bottoms and iron sides 3 feet high, while the larger ones are of similar materials but square and encased by a skeleton framing of light timbers. The filters in all consist simply of a false bottom of 1 inch wood, riddled with ½ inch holes, and resting on 1 inch-square strips nailed 8 inches apart to the tank bottom and covered with 10 ounce canvas served to fit the tank, the joint at the periphery being made by stuffing rags between the false bottom and side of tank. The system of continuous percolation is used, hence there is but one strength of solution and but one set of solution pipes. The drain-cocks below the filter bottoms are left wide open and solution is run in on the top as fast as it will run through the charge. At this plant it is usually a gentle stream about ½ inch in diameter flowing from a 2-inch pipe from each tank.

A novel feature here observed is the mode of adding the potassium cyanide to keep the solution up to standard strength. It having been found by experience that this ore uniformly consumed 1½ lbs. cyanide per ton treated, 1½ lbs. cyanide for each ton of ore in a tank newly charged and ready for its first wetting with solution are placed in a perforated tin tray about 24 inches square and 6 inches deep. (This is made from one of the old containers in which cyanide is purchased.) The tray with its charge is placed on top of the ore-charge under the pipe admitting solution, and flow of the latter is started at such a rate (learned by experience) that the ore is submerged at just the time when all the cyanide is dissolved. This practice was introduced to allow for the varying amounts of moisture retained in the sands, and insures a full strength of solution at the very commencement of leaching. The plan works well on this material which is very uniform in composition, the strength of stock solution being found to vary only a few points from month to month.

The leaching having been begun as described, a steady stream is kept running through the charge for from three to five days, depending upon the tonnage treated. Before discharging, a single water-wash is given, having first allowed the charge to drain for several hours or until no more solution runs off. It being necessary to keep the total bulk of solution on hand constant, the amount of wash-water is limited to the amount of moisture retained in a drained charge, which is 19%, or 1 ton of water to 4 tons of ore. The leached and washed residues were formerly removed by shoveling through bottom holes 18 inches in diameter into cars underneath, but later, water under pressure being available, V-shaped sheet-iron launders 24 inches on a side were placed beneath the tanks and residues are now sluiced out by means of 2 inch hose fitted with $\frac{1}{2}$ inch nozzle. With water under pressure of 60 lbs. per square inch, one man can sluice out 50 tons in 1½ hours—a great gain in economy over the old system.

The precipitation department is located adjacent to and below the level of the leaching-tanks, and the pregnant solution flows directly into the zinc-boxes, no intermediate tank being used, or at least only a very small one which is nearly always full. Ten rows of zinc-boxes with 10 compartments 12" × 12" × 10" in size to each, are in use. An interesting feature of this step is the remarkable ease and completeness of precipitation. The solution as it enters carries 0.97 oz. silver per ton and 0.082 oz. gold, and flowing through the 10 rows of loosely-packed boxes at an approximate rate of 3.1 tons per hour, leaves with 0.10 oz. silver and 0.01 oz. gold, or 88.7% precipitated. Considering the low grade of the entering solution and the perfectly careless way the zinc-shavings are distributed (each compartment having only a loose ball of zinc-shaving only half filling its space) this seems remarkable work. In other solutions in the writer's experience, especially where gold predominated, similar practice invariably resulted in imperfect precipitation.

The zinc is moved up one compartment in the usual manner every other day until a day or two before clean-up when it is allowed to run quite low. At clean-up, the rich material, now quite fine, is dipped out into tubs and rubbed through a 40-mesh screen, the small amount of coarse zinc remaining being returned to the boxes. The screened material together with whatever muddy liquor was unavoidably taken up with it, is placed upon a circular steam-dryer 6 feet across and 6 inches deep. The dryer is constructed of riveted boiler-iron, the steam chamber 2 inches deep being underneath. About 350 lbs. (dry weight) are got at each clean-up, that is, once a month. The steam dryer takes this down to 1% moisture in 18 hours, the lot being divided into three batches for drying. When dry, the material is shoveled into one of the tin-lined boxes in which cyanide is received, a cover is carefully soldered on, and shipment made by express to the Argentine, Kansas, plant of the American Smelting and Refining Company.

Local refining has been under consideration and would effect a considerable saving, the express rate being excessive on cyanide product as compared with an equal value of bullion, besides which only \$19.75 net per ounce is got for the gold against \$20.67 when in the form of bullion. The purity of this product is also favorable to the ordinary sulphuric acid method of refining. A partial analysis recently made by the writer is appended.

Gold	8.91%
Silver	70.16
Zinc	9.76
Iron	1.45
Lead	1.40
Silica	6.48
	92.56

The remaining 7.44% is probably principally cyanogen and oxygen.

The solution used in this plant shows a strength when titrated with silver nitrate solution without an indicator, of 4 lbs. cyanide per ton, but the same remarkable differences of results when the various standard methods are used as have elsewhere been observed are here encountered. This subject has been more fully discussed by the writer in the May, 1900 number of the Colorado School of Mines *Bulletin*. Using four standard methods results ranging from 1.3 to 4.3 lbs. per ton are got on this solution. Therefore, it is impossible to say, from the present knowledge of the reactions involved, exactly what the strength is, but for practical purposes of daily mill-work, any one of the methods may be used, provided that one is adhered to.

The alkalinity of the solution is fairly uniform at about 0.16% H_2SO_4 , i. e. an amount of alkali equivalent to this per cent. of H_2SO_4 .

The power for the plant which is needed for driving one rotary solution-pump with 2 inch discharge pipe, and the zinc-lathe, is got in the summer months from a small water-motor, and when water is short, a small boiler and steam-engine furnish power which was originally designed to be got from the com-

pany's electric generators, which latter cannot supply sufficient for other requirements of the property. About 7 hours pumping each day suffices to elevate the solution from sump to storage-tank situated above the level of the leaching-tanks, and about 25 lbs. of zinc-shavings are cut each day. Cutting 6 sheets of No. 9 zinc at once on a machine-lathe with automatic feed this can be done easily on the day shift. The sheets are wrapped around a 5 inch wooden mandrel placed in the lathe, the outside one being soldered in position. The cutting-tool is made of special steel known as "Mushet," which can be sharpened without injury on a dry emery-wheel.

The force required to operate the plant consists of a foreman, who also acts in the capacity of solution-tender on the day shift, one carman, two shovelers, and one night solution-tender, the first and last named working 12 hour shifts and the other ten.

As previously described, the slimes from the settlers are run into artificial ponds near the plant. When a pond is full (a pond being made to hold several months' run) the stream is diverted into another, and the first is allowed to dry for several months. The climate being arid, the upper two or three feet becomes well baked, and it is then conveyed by 2-horse wheeled scrapers to the upper end of the cyanide plant where it is dumped into cars which run to the leaching department. Alternate cars of this material and sands from the settlers are dumped into the leaching tanks and the regular continuous percolation treatment is given the charge. With the same length of time, excellent percentages of extraction are had provided the slimes are perfectly dry. Formerly a system of slimes treatment similar to that used and described by Mr. F. L. Bosqui at the Standard works in Bodie, California, was here in vogue but was too expensive for the values recovered. This consisted in ploughing up the still moist material, transporting it by means of wheeled scrapers and spreading it on the adjoining land to the depth of several inches or a foot. When dried out, a harrow was dragged over it and then the scrapers were brought into play to transport it to the cyanide plant.

The sands here treated have an average value of \$1.57 in gold and \$1.70 in silver, while the slimes carry \$3.19 in gold and \$5.03 in silver. The average extraction in the cyanide plant during the past six months has been 66.8% of gold and 37.7% of silver or 51.7% of the total value.

Somewhat of a novelty in cyanide plants of this class is being constructed for the Bull Run Mining Co. some 30 miles north of Tuscarora by Mr. H. C. Missimer. The ore, which has its value almost entirely in gold (about \$20 per ton) is to be crushed by stamps and passed over amalgamated plates. The entire product of the batteries goes to a set of circular tanks 12 feet × 12 feet, fitted with revolving agitators. Cyanide solution will probably be used in the mortars and the stream of pulp will flow into a given tank until it is full. The stream being then diverted to another tank, the first will be allowed to stand for a time. As much as possible of the supernatant solution will be decanted off and the remainder is to be drawn through the filter bottom by means of suction pumps. By this time the second tank will have been filled and the stream will be returned to the first. This is repeated until a suitable charge for agitation has been accumulated in each. When the agitator (which can be raised and lowered by means of an overhead hydraulic lift) is set in motion and the whole charge agitated with cyanide solution for a suitable length of time. With a quick extraction of values by agitation and rapid washing by use of the combined decantation and vacuum filter system, the plant is designed to handle its tonnage more economically than do those giving separate treatment to sands and slimes.

The idea of cyaniding stamp-mill tailings has found an extended application in the Black Hills of South Dakota in the direct cyaniding of ores, the stamp-mill being here used only as a crushing appliance. The practice originated with small companies already possessing a stamp-mill and wishing to give the cyanide process a trial on their ores, but is questionable as a basis for the erection of new mills. Admittedly, the stamp-mill makes more slimes than any other crushing machine, necessitating a two-fold treatment of the product and an extensive plant as compared with a plant using rolls or other fine-grinder for crushing and a vacuum to assist percolation. One of the early experimental plants has been described by Mr. John M. Henton in the *Mining and Scientific Press* of Mar. 10, 1899 and Sept. 8, 1900. At present there are several plants in the Black Hills district operating on similar lines, and the Portland Gold Mfg. Co. near Deadwood is putting in a very complete equipment under the supervision of Mr. E. B. Sawyer. At this plant it is designed to use cyanide solution in the batteries and to treat sands and slimes separately, the former by simple percolation and the latter by the South African system of circulating the pulp by means of sand pumps.

Mr. W. H. Gaze of New Zealand, writing in 1898, states that several New Zealand crushing plants have changed to this system, and he recommends it where conditions are at all favorable for wet-crushing, i. e. plenty of water, hard ores, fuel dear, etc. In Bosqui's Practical Notes on the Cyanide Process (1899) these plants are described in detail.

On the whole, cyaniding is being actively applied in this country, but improvements when made are not generally known and used by others because of the reticent policy of many operators and the indifference of our technical men to the general welfare of the industry. These conditions are in marked contrast to those existing in South African fields, where the Chemical and Metallurgical Society especially has done invaluable service in encouraging execution and publication of original work, and as a natural result most of our ideas in this line are gained from these contributors, many of whom are Americans. A like spirit in the generous interchange of ideas amongst metallurgists and managers in the United States would result in nothing but benefit to those interested in the industry.

WHEN IN BLACK AND WHITE.

Some Suggestions in Regard to the Attainment of a Neat and Clear Appearance in the Making of Mine Maps.

By Claude V. Martin.*

As yet, only in the offices of government and state departments, large land and mining companies, and the principal railways, is neat, precise, and effective drafting of surface and interior survey work held in high esteem. In, by far, the majority of cases it would seem that those who deem themselves as being unfortunate in having to foot the expense account are rather prone to regard resentfully either time or money spent, by those in charge of their workings, upon carefully made drawings. Still, there are many worthy men in the humbler ranks of mining engineers and superintendents throughout the country who are earnestly desirous of promoting the best interests both of their employers and the public at large in such work as that now referred to, though they are insufficiently paid and rarely thanked for so doing.

Not long ago a man who has charge of considerable work, fortunately most of it outside of this State, said in a blunt and bullying way, "When we have got orders, I don't want to waste any time with any foolishness as to poky details, in measurements which may interfere with the work, or waste my own time in the office. What the people want, who have got their money in the works, is to get a cash return for it without a dollar of extra expense. A few rough outlines have always been and always will be enough for practical men. A man don't get any thanks for picture work."

No one should be discouraged by such an utterance. It merely condemns the speaker and should stimulate to renewed effort the industrious, earnest, and ambitious employee.

Let it be kept in mind that it is as true today as when it was first said by Thomas Carlyle, that "Genius is merely an infinite capacity for the taking of great pains." Forgive me if at the outset I have strayed too far in a rambling detour from the point at which, perhaps, I should have begun. These notes are made solely for the benefit of those who are praiseworthy ambitious, but who are limited as to their ability as draftsmen by lack of training or practice or both. These suggestions only interest those whose office supplies are of the simplest sort. Any one really in earnest about his work will strive after uniformity. It can be attained by taking as a standard the plain, clear, and effective maps of the United States Geological Survey, and adopting from them the lettering and the simplest methods of indication for all the various features incident to an ordinarily complete map. A simple way to effect this would be to proceed as follows:

Take several sheets of linen-mounted egg-shell drawing paper, each sheet being 12 inches wide by 18 inches in length. Then, on the first sheet, fill in three or four alphabets of plain Roman capitals and lower-case letters. On the next sheet, prepare in relative proportions as many alphabets of Italic capitals and lower-case letters and stump capitals and lower-case letters. Of course, in the preparation of both of these sheets, one will carefully draw horizontal and vertical scale lines for the construction of these letters, such as may be found in any draftsman's alphabet book.

The third sheet may be filled with scale rules and compass points. As to the compass points it might be mentioned here that the best practice today seems to be that of using five lines of equal length, for the cardinal and semicardinal points, together with the variation line, crossing the dial plate. The center, where these lines cross each other, should be left as clean-cut and clear as possible. It is preferred by some, merely to leave a dot at the center and to allow, by a break in the continuity of each line, a small,

clear space about it. The lines should be finely and accurately drawn, and be of convenient length for protractor purposes, let us say 7 inches for a map of not less than 2 feet on its shortest side.

The fourth sheet might be devoted to equal spacings of the more common topographical signs. It may be well to warn the unpracticed draftsman against the cross-hatch or tie-mark indication for railroads. Few things mar the appearance of a map more than the irregular spacing of the numerous little cross-marks required for this conventional sign. If, by reason of the necessity for indicating canals, highroads, etc., it is out of the question to use either solid or link-filled lines to indicate railway lines, a good method of making even hatch-marks would be as follows:

Trace, on the bright side of dull-back tracing cloth, the center thread of your railroad lines. Take a sheet of thin paper with a calendered surface and lay upon it keel or ochre transfer papers; over this lay the tracing, and transfer from it the railway lines to the calendered paper beneath. Then, removing the tracing and transfer paper, mark parallel lines to the railway lines on both sides of the center thread, spacing them out twice the width of the center line on each side. Then, with a sharp knife, cut out the space between the two outside lines, leaving just enough points uncut to prevent the sheet from falling apart. Now take this thin paper sheet and place it in its correct position over the original drawing. Secure each section, of just a few inches of the work, while you are working on it, by weights. Set the section liner and commence to put in the cross-marks, using waterproof ink, being careful that the outsides of the pen are clean, and keeping the second finger on the two edges of the cut paper just in front of your section liner. Several good draftsmen use this method exclusively, and secure very fine effects.

The fifth sheet may be devoted to toning, that is, being laid off in blocks, showing regularly increased shades of blackness from a very light, almost imperceptible, gray, to the deepest tone consistent with the clear reading of the lettering or any other markings that have to be shown on the surface of a map. Remember that good even shading is produced only by repeated washings with tones of equal blackness. Never attempt to prepare tone washes with a liquid India ink. Use nothing but first-class stick India ink. Apply the brush to the stick and thus transfer the ink of the stick to the clear water in the saucer. Never rub the stick in the saucer. The first wash in the scale of tones should be barely perceptible upon white paper when dry. All other tones should be merely repetitions of this wash. One should accustom one's self to the use of a broad, flat, fine brush, the far edge of it being slightly raised, so that by capillary attraction the flow is most free at that edge nearest the hand.

In most out-of-the-way places one is not likely to enjoy the use of a modernly-equipped drafting board furnished with its universal joints, shifts, clamps, and screws. A simple device to aid the draftsman in shading with a common board is the clothes-pin slide. Every one is familiar with the common spring-snap clothes-pin. Constructed in a precisely similar manner, only 10 times as large, one can make a first-class tilting slide which can be kept moving up towards the draftsman with his left hand, while he runs in the shading with the right, the right elbow steadying the lower edge of the board. If one were to take a strip of thin brass, about $\frac{1}{4}$ inch wide and 5 inches long, and solder an iron pin, about the size of a shingle nail, to its center, and bend the flaps around the lower right-hand corner of the drawing board, fastening it securely with a couple of screws, he would have an excellent pivot and corner brace by which to regulate the shifting of the board.

Having prepared these sheets, the work thereon being as nearly as possible an exact reproduction in style and form of the work on the standard maps, note the dimensions of the map from which each separate letter or feature has been copied. When it has been determined what the size of the proposed map is to be, by the use of the pantograph, rapidly and correctly, such of the letters or features as may be required upon the drawing can be transferred to it in fairly true proportions. If the cost of even a cheap pantograph happens to be one of the lions in the way, that difficulty can be easily overcome by a little mechanical ingenuity. An illustrated catalogue of mathematical instruments can be obtained almost anywhere for the asking, and any of the simpler forms of pantographs will be a sufficient guide for the construction of a home-made article that will fairly answer its purpose.

In writing the foregoing, it has not been desired to lay down any cut-and-dried rules. The object has been rather to stimulate, by suggestion, the "rough-hand draftsman" to the development and successful employment of even better methods than those which have been mentioned.

It is well to strive to attain to the best effects, adaptable to the class of work in hand, without the use of colors. Years ago Professor Baker truly said, "If you cannot make plain the meaning of simple drawings in black and white, the reckless use of colors is apt to but emphasize your faults."

* Read before the Ohio Institute of Mining Engineers.

THE HEPPLEWHITE TAPERED PIT-PROPS*

And Bars—Causes Which Result in Breaking of Ordinary Props, and the Saving by Use of Tapered Props.

By W. Hutton Hepplewhite, H. M. Inspector of Mines. **

The destruction of wooden props, caused through breakage, when used in coal-mines, by the depression of the superincumbent strata, more especially in those mines having hard, impenetrable floors, is a serious item in the cost of coal-working. Anything that helps to obviate such destruction, consistent with the safety of the workmen employed, will be welcomed by colliery-owners whose timber-bills, resulting from the enormous quantity of props broken and rendered useless for re-setting, are very high.

It is a well known fact that in extracting a coal seam of ordinary thickness, apart from the cost of so doing, the waste cannot be stowed so as to have the same solidity as that which it had before the extraction of the coal. It therefore follows that the roof inevitably must sink, more or less, according to the thickness of the seam and the nature of the superincumbent strata.

From numerous measurements which the writer has had the opportunity of taking in various coal-seams, he finds that the

thick wooden props. The writer has observed that, when steel props are used, and the wood at the top and bottom has been penetrated to the utmost limit, they begin to bore into the roof, which makes an opening, and probably gives a loose-end to a large piece of rock.

The circular issued by the Secretary of State on August 9th, 1899, to colliery proprietors, foreshadows legislation enforcing "systematic timbering" in coal-mines; and mines that have not already adopted some system of timbering, namely, the setting of props at the working-face at a stipulated distance apart, may find their timber costs considerably augmented thereby.

The writer believes that he has to a great extent solved the problem of preventing the breakage of props, when used under ordinary normal conditions, by simply thinning or tapering one end of the prop, allowing it to yield to the sinking roof, so that, instead of the prop breaking, the tapered end will "burr" or "fuzz" up the taper. The writer anticipates that the thinning, or weakening, of one end of a prop will be regarded by some mining engineers as altogether opposed to the principle of safely supporting the roof of a working-place, especially by those who have adopted the use of steel or extraordinarily thick wooden props.

An endeavor will now be made to show how the tapered prop

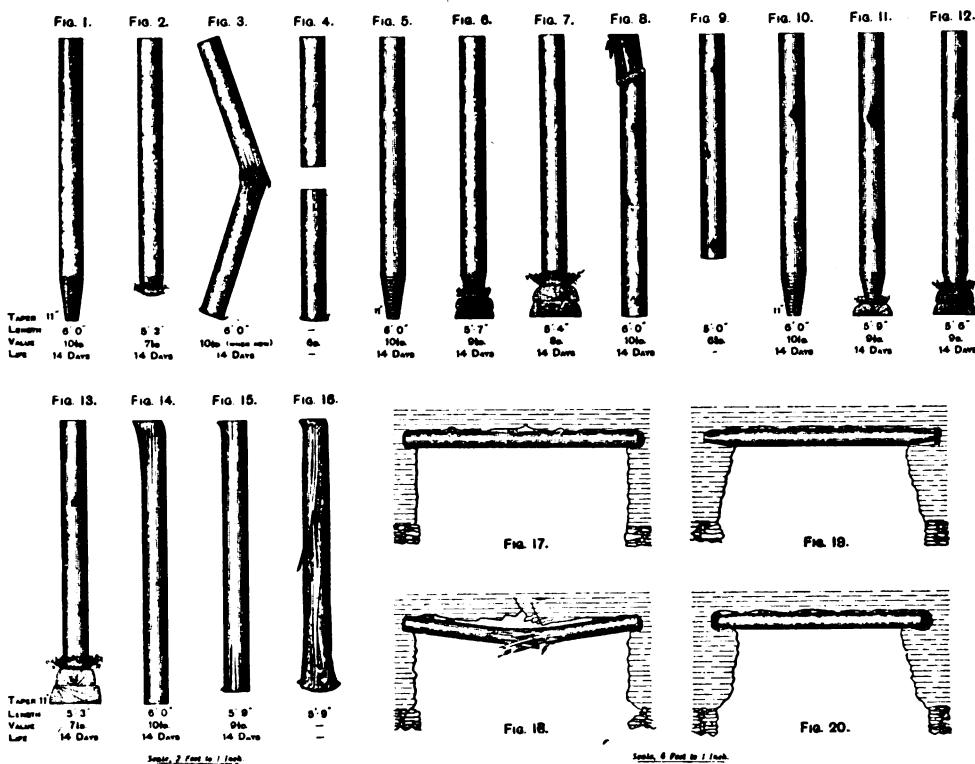


PLATE I.

depression varies from 2 to 7 inches at a distance of 6 feet back from the coal-face. The roof of the Top Hard coal-seam has a subsidence of 1 inch per foot of distance from the face, generally throughout the district. This amount of depression is not surprising if we consider the large area of exposed waste where the longwall system of working is adopted. It is no unusual occurrence to have 6,000 feet, or even more, of working-face advancing simultaneously, under a weight of superincumbent strata many hundred feet thick.

Undoubtedly a heavy subsidence is quietly and imperceptibly taking place, and the wooden props commonly used in coal-mines are not strong enough to withstand the weight. Therefore they give way in the shape of either kneeling, buckling, or some other form of breakage, rendering them of no further use as pit-props. It is usually found, where this depression takes place over a large area, that the roof over the broken props is not resting on them to any appreciable extent, simply because the superincumbent strata have settled down bodily, in spite of the props, to such an extent that locking or keying-together ensues, and the depression back in the waste continues at a much slower rate.

Some collieries use steel props and thick pieces of wood at the top and bottom, rarely allowing more than two rows of props to stand along the face. Others, again, have adopted extraordinarily

made to show how the tapered prop acts, when first set and during the subsequent stages. We will take a prop, 5 feet long and 6 inches in diameter at the thin end, and after tapering one end, use it in a pit in the ordinary course of working. Having previously ascertained that the normal depression of the roof is 6 inches, 6 feet back from the face, we calculate that the prop will require a taper 11 inches long, leaving the thin point 3 inches in diameter. Of course it must be understood that these props were only intended for hard, impenetrable floors, exception being taken where a few inches only of soft clunch overlies a hard floor.

A prop so treated will probably sustain a dead weight of about 16 tons, before any appreciable impression is made on the tapered end. In time, the superincumbent strata over a certain area are quietly and imperceptibly settling. The smaller diameter of the tapered end of the prop will be observed to have begun to "burr" or "fuzz," and the greater the pressure the more will it advance along the taper to the ordinary thickness of the prop. When the time arrives for its withdrawal, the prop so treated will be found erect and sound, whilst an ordinary prop would have been broken in some shape or form.

After the withdrawal of the prop, supposing that the "burring" has advanced, say, 4 to 5 inches along the taper, it can be re-set in the same stall on a foot-lid, and the "burring" will proceed again on the same principle. In fact, it follows that so long as a weak point is made at the end of the prop, and rendered relatively weaker than the other portion, the prop may be re-set in suitable places as long as there is length to set. Finally, when too short for use as a prop, it can be cut up for lids or sleepers.

When props are set in a working-place to sustain the roof, immediately following a web of coal, they do not sustain the whole of the superincumbent strata, but merely a portion, varying from a few hundredweights in some mines to a few tons in others. The greatest breakage of props, according to the writer's observation, occurs 5 feet from the face and beyond.

The pecuniary advantage derived from the use of tapered props will be obvious to colliery-managers. At one large colliery, in which tapered props had been wholly in use for some months, the consumption of props had been reduced fully 25 per cent., and broken props had become a thing of the past.

When bars or stretchers are required upon roadways to support the roof, and the side pressure of such roadways is excessive, it is not unusual to see the timbers speedily broken somewhere near the centre, principally, and in most cases, wholly, owing to side pressure, and the original object for which they were set is nullified. Such timbers have to be re-set, and the cost of timber and

* British patent, May 11th, 1899, No. 9,925.

** Transactions Institution of Mining Engineers, April, 1900.

of labor is doubled. Bars or stretchers having both ends treated similarly to the props, the ends being relatively weaker than the middle portion, would "burr" or "fuzz," thus saving the timbers from breakage, and at the same time more securely supporting the roof.

The tapering can be done either by manual labor, machinery, or any other convenient method, and should not exceed in cost $\frac{1}{4}$ d. per prop.

An entire seam, or even a district, in which tapered props are used throughout is a gratifying sight, as compared with the use of the old form of prop. Every prop is standing erect and sound, firmly supporting the roof, and props that have been re-set three times do not show a splinter. No prop will be found to have pierced through the lid and to have penetrated the roof; and consequently there is not a single break in the roof throughout a district, which has settled down to its natural subsidence. Such evidence proves that props set to support the working places with a weak point, such point forming a cushion, will allow the roof to find its natural depression without breaking into it. The workmen are in greater security, and the props are more easily withdrawn.

The accompanying drawings (Plates I and II) represent ordinary props and tapered props, when used under exactly similar conditions, and nearly all the figures have been reproduced from actual specimens. Each setting is supposed to last 14 days, the average length of time occupied in loading a web of coal out of a stall, and in moving forward the props. The value of the original prop is based on present-day prices, and after each re-set a proportionate value for loss of length has been deducted, although in reality the value of each set to the owners would be the same, namely, $10\frac{1}{4}$ d.

Fig. 1 (Plate I) represents a fir-wood pit-prop, 6 feet long, and 6 inches in diameter, with a taper at one end of 11 inches, and the thin point, 3 inches in diameter. Fig. 2 (Plate I) shows the length of taper destroyed by "burring," and after the prop is trimmed with an axe it can be re-set in a suitable place.

Fig. 3 (Plate I) shows an ordinary prop "buckled," and rendered useless for re-setting, but it can be utilized for lids, as shown in Fig. 4.

Figs. 5, 6 and 7 (Plate I) represent a tapered prop, and three settings, foot-lids being used to retain them for use in the same working place. The writer does not advocate the general use of foot-lids, especially in the shape of broken pieces of timber with an uneven surface.

Lids, when used, should be made especially for the purpose, and should not be of a less breadth than the props, and if this requirement be attended to, the lids would then form an essential part of the prop.

Fig. 8 (Plate I) shows a prop sheared at a point about 1 foot from the top, and when the sheared part is sawn off, it can be cut into sleepers or lids, as shown in Fig. 9 (Plate I).

Figs. 10, 11, 12 and 13 (Plate I) represent a tapered prop set four times in the same working place, and it could then be sent out of the pit and re-tapered for use in a thinner seam.

Fig. 14 (Plate I) represents an ordinary prop; and after being set twice, it is crushed and sheared as shown in Fig. 15 (Plate I), and is then useless except for building into a corner chock (Fig. 16, Plate I).

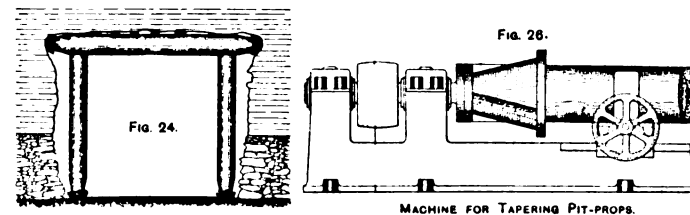
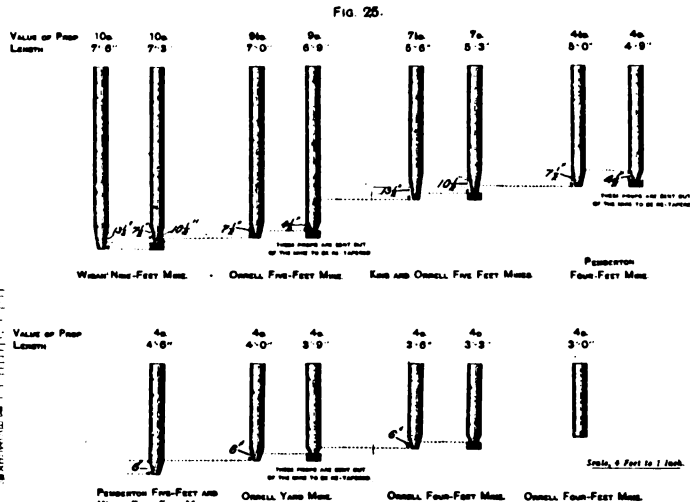
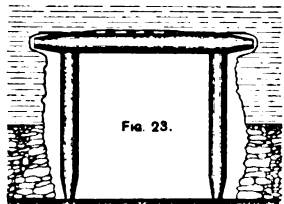
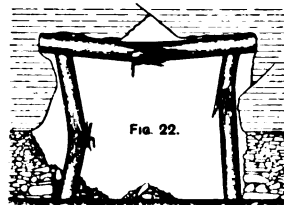
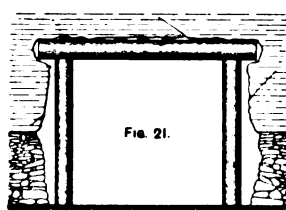
Fig. 17 (Plate I) shows an ordinary larch bar let into the sides of a packed roadway to sustain the roof; and side pressure eventually produces the result shown in Fig. 18 (Plate I). Fig. 19 (Plate I) represents the same kind of bar with both ends tapered, and the result, when the side pressure operates on the ends, is shown in Fig. 20 (Plate I). An expensive bar is thus saved from breakage, and the roof is securely held.

Fig. 21 (Plate II) shows an ordinary larch bar with two fir-wood props set on a packed roadway; and Fig. 22 (Plate II) shows the result after both top and side pressures have played their part. Fig. 23 (Plate II) shows the use of tapered bars and props and Fig. 24 (Plate II) proves the resulting safety of the method.

Fig. 25 (Plate II) exhibits the history of a tapered prop, and how it may be made serviceable when carefully looked after. This experiment was actually carried out at the Pemberton collieries, Lancashire, and the writer is indebted to Mr. Ernest Douglas who has established that repeated setting of the same prop does not materially weaken its strength.

The machine for tapering props (Fig. 26, Plate II), is fitted with removable knives. It has a traveling table, similar to the table on a pipe-screwing machine, controlled by a rack-and-pinion. The prop is secured to this table by a clamp, with right-and-left-hand screws. Each machine will taper about 30 props per hour, and about 4 horsepower is required to drive it.

The results of the writer's measurements of the depression of the roof at several collieries and in different coal-seams are given below. A stall, working on the longwall system, was selected with a level roof, which is a true indication there had been no abnormal weighting of the superincumbent strata; then as near as practicable to the coal-face, the height from the floor to the roof was measured; then the heights at distances of 6 feet, 9 feet and 12 feet back into the waste or gate-road were similarly measured and thus one obtained the actual depression of the roof when working the coal under normal conditions. The average depression at 6 feet back from the face, varied from 2.69 inches



in the Deep Soft coal seam to 5.66 inches in the Top Hard coal seam, and the observations varied between 2 inches and $7\frac{1}{2}$ inches.

Table I has been prepared from Table II and shows that the estimated saving, which may be anticipated, by using tapered props exceeds 50 per cent.

TABLE I.—SHOWING THE PERCENTAGE SAVINGS OBTAINED BY THE USE OF TAPERED FIR-WOOD PROPS, 6 FEET LONG AND COSTING $10\frac{1}{4}$ d. EACH.

No.	Cost of Prop after deduct- ing the Value of the Wood used as Lids and Sleepers.	Life.	Cost per Prop per Week.			Saving obtained by the Use of Tapered Props.
			Tapered Props.	Ordinary Props.		
				Sheared.	Buckled.	
	Pence.	Weeks	Pence.	Pence.	Pence.	Per cent.
1	4½	4	1.125			
	4½	2			2.500	50
2	4½	6	0.750			
	3½	2		1.875		60
3	4½	8	0.562			
	10¼	4			2.625	78

Table II records the costs or values of each prop shown in the illustrations (Figs. 1 to 15, Plate I).

TABLE II.—SHOWING THE COMPARATIVE VALUES OF TAPERED AND ORDINARY FIR-WOOD PROPS, 6 FEET LONG AND COSTING 10¢D. EACH.

Number.		Tapered Props.				Ordinary Props.			
		Plate I.	Length of Prop.	Value of Prop. etc.	Life.	Plate I.	Length of Prop.	Value of Prop. etc.	Life.
		Fig.	Ft. Ins.	s. d.	Weeks.	Fig.	Ft. Ins.	s. d.	Weeks.
1	Settings:								
	First	1	6 0	0 10	2	3	6 0	0 10	2
	Second	2	5 3	0 7	2				
	Lids			0 6		4	2 8	0 6	
	Fire-wood							0 1	
	Totals			1 11	4			1 5	2
2	Settings:								
	First	5	6 0	0 10	2	8	6 0	0 10	2
	Second	6	5 7	0 9	2				
	Third	7	5 4	0 8	2				
	Lids			0 6					
	Sleepers, etc.					9	5 0	0 6	
	Totals			2 9	6			1 5	2
3	Settings:								
	First	10	6 0	0 10	2	14	6 0	0 10	2
	Second	11	5 9	0 9	2	15	5 9	0 9	2
	Third	12	5 6	0 9	2				
	Fourth	13	5 3	0 7	2				
	Lids			0 6					
	Totals			3 6	8			1 8	4

The results recorded in Table III have been obtained from a colliery, in which the tapered props have been in use throughout the workings in the Top Hard coal-seam for several months, and the figures have been derived by noting the consumption in each case.

TABLE III.—SHOWING THE SAVING EFFECTED AT A COLLIERY USING FIR-WOOD PROPS, 5 FEET AND OVER IN LENGTH AND COSTING 10¢D. EACH.

	Life	Weeks	Tapered Props.		Ordinary Props.	
			Sheared.	Buckled.	Sheared.	Buckled.
Cost per prop per week		Pence	1.79	2.687	5.375	
Gain by using tapered props		Per cent.		33	66	

[The discussion of this paper brought out a large amount of corroborative evidence to support the data given by the author from persons who had experimented with the tapered timbers.]

CURRENT MINING DECISIONS.

Prepared for MINES AND MINERALS.

Evidence as to Boundary Lines.—Under evidence that 1,500 feet running southerly along the ledge from plaintiff's northern stake and shaft, as described in their notice of location, would end a short distance north of what plaintiffs claimed to be their southerly end line, the court properly confined plaintiffs to the limit of 1,500 feet.—*Conway et al. vs. Hart, 62 Pac. Rep. (Cal.) 44.*

Monuments Not In Place.—A patent to a mining claim will not be reformed in equity, so as to make the calls therein correspond with alleged monuments located on the ground, where it appears that for about 16 or 18 years preceding the filing of the bill the alleged monuments were not in place, and there is as much doubt as to where the monuments were first located as there is whether the course is correct.—*Thallman et al. vs. Thomas, 102 Fed. Rep. (U. S.) 935.*

Upper and Lower Proprietors on Stream.—Where there are two ore mills in operation on the same stream, the lower proprietor may be compelled to take some steps and be at more expense than he would if he were the proprietor on the stream; and it is the duty of the upper proprietor to use great care and caution, and to take such action as will avoid, as far as possible, any injury occurring to the lower proprietor by the flow of tailings from his mill.—*Othaeite Gold & Silver Min. & Mill Co. vs. Dean, 102 Fed. Rep. (U. S.) 929.*

Reasonable Compliance with Statute.—The law will not hold the locator of a mining claim to a strict and technical observance of the statute in respect to the terms of his notice, so long as he substantially complies with its requirements; and if it appears that the location was made in good faith, and by any reasonable construction, in view of the surrounding circumstances, the

language employed in the description will impart notice to subsequent locators, it is sufficient.—*Wells vs. Davis et al., 62 Pac. Rep. (Utah) 3.*

Records of a Mining District as Evidence.—Objection to the admission of the record of mining claims of a special district in evidence, without proof that there was such a district and a custom requiring a record, and that the book came from the proper custody, is not well taken, where the pleadings admitted that the claims were in the district, and the complaint alleged, and was supported by proof, that G. was the recorder of such district, and G. was called by both sides to produce the record of their location notice.—*McCann et al. vs. McMillan et al., 62 Pac. Rep. (Cal.) 31.*

Sufficiency of Marking of Claim.—Several years prior to their location of the mining claim in controversy plaintiffs having located the same claim, and placed stakes, with mounds of rock, at each corner of the surface ground, and at the centers as the end lines, their adoption of these stakes in making a second location was a sufficient compliance with Rev. St. U. S. § 2324, requiring that the location of a claim be distinctly marked on the ground, so that its boundaries can be readily traced.—*Conway et al. vs. Hart, 62 Pac. Rep. (Cal.) 44.*

Vacant Public Land.—Evidence that before the first location of plaintiffs' claim the land was unoccupied by anybody, and was vacant government land; that before their second location plaintiffs worked the claim for several years, placed stakes around it, sunk a shaft, and took out rock; and that when they made the second location they found the stakes, shaft and claim in substantially the same condition as when they left it,—is sufficient to show that the land was vacant public land when the second location was made, as against a subsequent locator asserting no title antedating his location.—*Conway et al. vs. Hart, 62 Pac. Rep. (Cal.) 44.*

Description that will Identify Claim.—The description of a mining claim in a notice of location by metes and bounds, with reference to permanent stone monuments erected at the four corners and at the center of the east and west end lines of the claim, is sufficient, under St. 1897, p. 215, requiring a description which defines the exterior boundaries as they are marked upon the ground, and such additional description reference to some natural object or permanent monument as will identify the claim, especially as against a subsequent locator who finds the bedding and tools of the previous locator upon the claim, and an employee holding possession for them.—*Talmadge et al. vs. St. John et al., 62 Pac. Rep. (Cal.) 79.*

Sufficient Showing of Gold-Bearing Lode.—Evidence that, prior to the location of the claim in question, plaintiffs had sunk a shaft 25 or 30 feet, and had taken from it a considerable amount of quartz rock, which formed a dump, and that rich rock was found, and that in surveying the claim the surveyor measured along the lode line, taking his direction for the course of the vein from a line drawn from a shaft through two or three prospect holes where the ledge was exposed, together with the admission of the contesting claimant that the rock taken out was gold-bearing, is sufficient to show that a gold-bearing lode or vein had been discovered by plaintiffs within their claim at the time the location was made.—*Conway et al. vs. Hart, 62 Pac. Rep. (Cal.) 44.*

Forfeiture of Lease.—The lessor having permitted the lessee to locate a well under the lease, and himself constructed a dam to obtain water with which to drill it, sold and delivered wood for fuel to the contractor employed by the lessee to drill the well, and lodged and fed the men who were doing the work, after three months from the date of the lease had expired, and down to the very day that he made a new lease to another party, thus inducing the lessee and those claiming under him to believe that he was satisfied with their efforts at development, and that it was not his intention to claim a forfeiture, he will not be permitted in equity, to insist that the first lease was forfeited at the time the second was executed, even though grounds to declare a forfeiture existed.—*Duffield et al. vs. Michaels et al., 102 Fed. Rep. (U. S.) 820.*

Liability Created by Statute.—Hurd's Rev. St. 1889, c. 93, § 6, provides that a sufficient light shall be furnished at the top of every shaft of a mine to insure the safety of persons getting on or off the cage; section 8 requires the top of every shaft to be securely fenced to protect the entrance to the shaft; and section 14 declares that, for any injury to person or property by wilful failure to comply with the provisions of the act, a cause of action shall accrue. Held that, where a declaration against a mining company alleged that, plaintiff's intestate came to his death by defendant's wilful omission to comply with sections 6 and 8, it was proper to refuse to allow officers of defendant to testify that they intended to comply with the statute in good faith, since the word "wilful," as employed in the declaration, did not involve a charge of wrongful intent, but only that the omissions were conscious acts of the mind, and not from mere inadvertence.—*Odin Coal Co. v. Denman, 57 N. E. Rep. (Ill.) 193.*

PERSONALS.

The annual meeting of the Canadian Mining Institute has been announced to be held at the Windsor Hotel, Montreal, March 6, 7, and 8, 1901.

Captain James W. Paul, chief mine inspector, West Virginia, is receiving congratulations on account of his marriage, January 23, 1901, to Miss Wilson, of Rochester, Pa.

Mr. H. G. Merry has severed his connection as General Manager and Agent of The Low Moor Iron Co., of Virginia, which position he has held for the past 13 years, and he will spend the winter in Florida and the West Indies.

Mr. A. T. Watson has been appointed purchasing agent for the following companies, succeeding Mr. L. L. Malone, who has been appointed general superintendent: The Montana Coal and Coke Company, West Fairmont Coal and Coke Company, Briar Hill Coal and Coke Company, and the Gaston Gas Coal Company.

D. H. Bacon, of Duluth, who has been president of the Minnesota Iron Co. for the past ten years, will on February 1 resign his position to become chairman of the board of directors of the Tennessee Coal, Iron & Railroad Co. Mr. Bacon will reside in New York City and will have the direction and management of all the departments of the company's business.

Mr. George Clinton Gardner, until recently in charge of the coal department of the Pennsylvania Railroad, has been elected president and general manager of the Flemington Coal & Coke Company, in place of Mr. Joseph T. Redding, resigned. Mr. S. L. Simpson, the vice-president and general manager, also resigned, and Mr. Gardner takes over the duties of general manager as well as those of president.

Mr. William Penn Morgan has assumed charge of the Vinton-dale Colliery, Cambria County, of the Lackawanna Iron & Steel Company as general superintendent. Mr. Morgan was for nearly 30 years connected with the Lackawanna Iron & Steel Company's coal department, and when this company gave up its Capouse and Pine Brook collieries to the Scranton Coal Company he was made superintendent of the latter colliery, which position he left August, 1899, to become foreman of the Diamond colliery.

Mr. T. H. Watkins, president Temple Iron Company since its formation, has resigned from that position, his resignation taking effect January 1, 1901. He is succeeded by Mr. George F. Bear, a director of the Philadelphia & Reading R. R. Company, and former vice-president of the Temple Coal & Iron Company. Mr. Watkins is relieving himself as much as possible from his anthracite coal business so that he may devote himself more entirely to his extensive interests in West Virginia and Western Pennsylvania bituminous coal fields.

Mr. M. S. Harlow, Manager of the Boston Office of the Ingersoll-Sergeant Drill Co., died as the result of typhoid fever, at his home in Malden, Massachusetts, Saturday, December 29, 1900. Mr. Harlow had been connected with the Ingersoll-Sergeant Company for over 15 years, first as a salesman and then as Manager of the Boston Office, during which time he has served the interests of the company as well as those of its customers most faithfully. He was an upright, loyal man, a faithful employee, and a trusted friend.

At the annual meeting of the Illinois Coal Operators' Association, held in Chicago, December 21, the following officers were chosen to serve for the ensuing year: President, O. L. Garrison; Vice-president, J. A. Agee; Secretary-Treasurer, E. T. Bent, and Recording Secretary, C. L. Scroggs. Executive Committee—H. N. Taylor, A. L. Sweet, S. M. Dalzell, J. H. Garaghty, W. W. Keefer, Edward Brown, Lee Kincaid, D. G. Shumway, T. W. Lukins, Walter W. Puterbaugh, C. T. Parker, E. C. Donk, A. J. Moorshead, C. C. Davis, C. E. Hull, T. B. Eaton, T. S. Peabody, M. C. Wright, Isaac Wantling, Richard Newsum, G. W. Traer, Randolph Smith, William Smithers and George T. Cutts. O. L. Garrison, chairman, executive committee.

The following promotions and appointments of Superintendents of the Coal and Water Companies of the Pennsylvania Railroad Company took effect January 1st, 1901: Mr. Francis H. Kohlbraker, Superintendent Mineral R. R. & Mining Co. to be Superintendent of the Susquehanna Coal Co., and Superintendent of the Nanticoke Water Co., with Headquarters at Nanticoke, Pa., vice Mr. John H. Tonkin, resigned. Mr. Robert A. Quin, Superintendent Susquehanna Coal Co., William Penn Colliery, to be Superintendent Mineral R. R. & Mining Co., with headquarters at Shamokin, Pa., vice Mr. F. H. Kohlbraker, promoted. Mr. Eugene A. Rhoads, Assistant Superintendent Susquehanna Coal Co., Nanticoke, Pa., to be Superintendent of William Penn Colliery, Susquehanna Coal Co., Headquarters at William Penn, Shaft Post Office, Pa., vice Mr. Robert A. Quin, promoted.

The names and addresses of the executive officers of the International Steam Pump Company have recently been given out for the first time since the resignation of President C. C. Worthington. They are as follows: John W. Dunn, president, 26 Broadway, New York City; Marcus Stine, first vice-president, 30 Broad Street, New York City; Chas. L. Broadbent, second vice-president, 26 Broadway, New York City; Max Nathan, treasurer, 26 Broadway, New York City; James H. Snow, secretary, 26 Broadway, New York City. Directors: John W. Dunn, Max Nathan, Marcus Stine, James H. Snow, Charles L. Broadbent, Frederick M. Wheeler, Philip Lehman, Harry B. Hollins, Harry E. Knapp, John E. Borne, Arnold Tanzer, Theodore L. Hermann, Joseph Seep, Charles N. King and Daniel O'Day.

At the semi-annual meeting of the Retail Coal Dealers' Association of Illinois and Wisconsin, at Milwaukee, last week, the following changes were made necessary among the officers, owing to Mr. Delos Hull, Oak Park, Ill., having entered the wholesale trade: Vice-President R. C. Brown, Oshkosh, succeeds Mr. Hull as president; Mr. William Sanford, Freeport, Ill., one of the executive committee, becomes vice-president, succeeding Mr. Brown. Every officer and member of the executive committee was present: President Delos Hull, Vice-President R. C. Brown, Secretary F. E. Lukens, Chicago; Treasurer J. F. Harral, Aurora, Ill.; W. M. Sanford, Freeport, Ill.; Theodore Huber, Watertown; C. L. Marston, Appleton; John W. Adams, Peoria; H. B. Bartholomew, Batavia, Ill., and Frank Durkee, Lake Geneva. The officers and members were tendered a banquet at the Plankinton House by the wholesale coal trade of that city.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

THE HUG WATER WHEEL. D. Hug, Denver, Colo. 41 pages.

THE CRANE BLOW-OFF VALVE. Crane Company, Chicago, Ill. Pamphlet 3 pages.

"STEVEDORE" TRANSMISSION ROPE. C. W. Hunt Company, West New Brighton, N. Y. 8 pages.

ELECTRICAL CONDUCTORS. The American Steel & Wire Company, The Rookery, Chicago, Ill. 32 pages.

"STEVEDORE" TRANSMISSION ROPE WITH PATENT COUPLINGS. C. W. Hunt, West New Brighton, N. Y. 8 pages.

WIRE ROPE AND ITS APPLICATION TO THE TRANSMISSION OF POWER, &c. The Trenton Iron Co., Trenton, N. J. 51 pages.

THE CONCENTRATOR OF MINERAL BEARING ORES. The Hooper Pneumatic Milling Company, Baltimore, Md. 14 pages.

CHICAGO HOUSE WRECKING CO., West 35th & Iron Sts., Chicago, Ill. 232 pages, illustrated catalogue and price list.

"A SHORT ILLUSTRATED SKETCH FROM LIFE." Atlas Pipe Wrench Co., 121 Liberty St., New York. Pamphlet 4 pages.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., Pittsburg, Pa. Belt-Driven Single-Phase Alternators. 12 page circular. Circular Index No. 2. 4 page circular. Engine-Type Alternators.

"WHERE THE NEW CENTURY WILL REALLY BEGIN." Joseph Dixon Crucible Co., Jersey City, N. J. 16 pages. Also, by the same firm, Dixon's Silica-Graphite Paint. Pamphlet 3 pages.

THE THEW AUTOMATIC SHOVEL CO., Lorain, Ohio. Circular No. 1, illustrating single truck types of shovels operating in a complete circle. 5 pages. Circular No. 2, describing excavator type machines. 9 pages.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y. Type H Transformers in Use. 41 pages, containing testimonials from firms using these transformers. Railway Motor Controllers, Bulletin No. 4238. 10 pages. Red Core Wires and Cables. 2 page circular. White Core Wires and Cables. 2 page circular. Also 1 page circular describing Improved Bracket for Series Incandescent Street Lamps.

CALENDARS RECEIVED.

NITRO POWDER COMPANY, Kingston, N. Y.

THE LUNKENHEIMER CO., Cincinnati, Ohio.

MACOMBER AND WHITE ROPE CO., Chicago, Ill.

THE PHILIP CAREY M'F'G CO., Lockland, Ohio.

BETHLEHEM STEEL COMPANY, South Bethlehem, Pa.

MORGAN-GARDNER ELECTRIC COMPANY, 2638 Shields Ave., Chicago, Ill.

DAVIS BROS., Ellsworth Colliery, Saint Clair, Pa. Mammoth Vein White Ash Coal.

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FAKE STRIKE REPORTS.

EVER since the settlement of the recent anthracite strike certain journals have persistently done all in their power to keep the discussion stirred up, and have constantly been making prophecies that the United Mine Workers were planning a gigantic strike all over the United States which would be inaugurated April 1st, 1901, when the present agreements between the operators and the miners expire.

While we do not claim to have "inside information," we do know that the writers of the articles in these yellow journals are utterly irresponsible, and that these reports are pure fabrications of the imagination just as were the reports of the strike contained in these same papers. The iniquitous and thoroughly untrustworthy reports sent from the anthracite region and many of the photographs published were totally devoid of truth, and the greatest harm done to the miners' cause was through just such misrepresentations. The real condition of affairs always becomes known ultimately, and when the general public finds that it has been fooled in so many particulars it naturally goes to the extreme and concludes that it has been hoaxed in every point, and that the grievances of the men, no matter how just they may have been, existed only in the disordered brains of the irresponsible and untrustworthy correspondents.

A very sensible editorial in the United Mine Workers' Journal, which is the official organ of the United Mine Workers of America, gives the lie direct to all of these rumors of a general strike April 1st. This editorial says: "So far as the Journal is concerned we have no knowledge of any anticipated trouble April 1st, and feel confident that the Columbus convention of the miners and operators will again effect an agreement along the lines which have proven mutually satisfactory for the past three years."

The same editorial says in another portion, "The annual 'Gigantic Miners' Strike' headlines have reappeared in the daily papers. With a regularity seldom equaled these 'hair raising' announcements appear just prior to the meeting of our annual convention. As usual this 'scoop' relates in detail the great preparations being made by the operators for the shut-down April 1st, also cites to the extra efforts of the organization in West Virginia and other points, and concludes with a description of present activity in the anthracite field, and the usual statement concerning the stocking of coal is appended. This fake story is so well understood by experienced miners that it hardly necessary to refer to it."

What may develop in the next two months no one can foretell, but these editorials certainly indicate that so far as the men themselves are concerned there is no concerted plan on foot, and it is regretted that papers with the circulation many of the metropolitan journals have should lend themselves to stirring up trouble in an industry where everything is at present comparatively quiet. In the words of the editorial quoted above, "the circulation of such sensational reports is injurious to the trade, as it tends to destroy confidence and makes each party suspicious of the other, thus laying a foundation for unnecessary trouble."

CONCILIATION AND ARBITRATION.

THE following appeal to the American people was adopted at the Conference on CONCILIATION AND ARBITRATION, held under the auspices of the National Civic Federation, at Steinway Hall, Chicago, Illinois, December 17th and 18th, 1900.

To the American People—Greeting:

The Conference on Conciliation and Arbitration, held under the auspices of the National Civic Federation, animated by a desire of witnessing some practical benefits to the people of our land growing out of these deliberations, desires in a spirit of fairness to make a public appeal for greater sobriety of judgment on a subject of the first importance. We believe that the present time is peculiarly fitting, standing as we do, on the border line of two centuries, to make such an appeal, and we believe we could in no better way employ the last days of a dying century than by preparing ourselves for the highest duties of citizenship in the new century upon which we are so soon to enter.

While addressing ourselves, for apparent reasons, more directly to all those

who are called upon to mould thought and to shape public opinion, chief among which agencies are the pulpit and the press, this appeal is, however, intended for every American citizen of whatever station in life.

The secret of good citizenship we believe to be the restraint which the individual can and does place upon many of his own natural inclinations, while the secret of success in life is, after all, dependent on the efforts which the individual makes to work out his own salvation, and the individual citizen is, therefore, specially urged to take a personal interest in the work outlined by this conference.

We duly recognize that unless labor is regularly employed and has reason to be satisfied with its wages and conditions in life we cannot have permanent peace nor substantial prosperity. We also recognize that capital must find adequate returns for its investment if wages are to be fair and discontent is to be averted.

To the end that tranquillity in the industrial world may prevail, this Conference on Conciliation and Arbitration would make the following recommendations to the American people:

1st.—That employers and wage-earners should enter into annual or semi-annual agreements or contracts.

2d.—That all industries in the United States should establish boards of conciliation within the several and varied interests, to which boards of conciliation all differences and disputes arising between employer and employe, if not readily adjusted between the immediate interests concerned, may be referred for settlement.

3d.—Recognizing the fact that compulsory arbitration, aside from all other objections urged against it, is not at this time a question of practical industrial reform, and inasmuch as such systems of arbitration now in vogue do not seem fully to meet the requirements of the different interests, and appreciating the importance of the subject,

We, therefore, recommend that the presiding officer of this conference appoint a committee to serve for a period of one year, to be composed of six representatives of the employer class, and six representatives of the employe class, these representatives to be selected as nearly as possible from the different sections of the country, for the purpose of formulating some plan of action looking to the establishment of a general system of conciliation that will promote industrial peace.

We would recommend also that this committee of twelve be given power to appoint such auxiliary committees from the industries, trades, and professions as may seem best to promote the work of conciliation and education.

We believe that this conference will have, in part at least, failed of its mission unless it strenuously insists that the proper time to arbitrate is not after a strike or lockout has been inaugurated, but before it has begun. We fully realize that all plans of arbitration and conciliation will be unavailing unless we are all animated by a spirit of fairness and justice and are willing to open our eyes to such rights as belong to every citizen.

(SIGNED)

A. C. BARTLETT,
Vice-President Hibbard, Spencer, Bartlett & Co., wholesale hardware.

HENRY W. HOYT,
President National Founders' Association.

HERMAN JUSTI,
Commissioner Illinois Coal Operators' Association.

G. WATSON FRENCH,
Vice President Republic Iron and Steel Company.

E. D. KENNA,
Vice-President Atchison, Topeka & Santa Fe R'y System.

CHAUNCEY H. CASTLE,
President Stove Founders' National Defense Association.

SAMUEL GOMPERS,
President American Federation of Labor.

JOHN MITCHELL,
President United Mine Workers of America.

MARTIN FOX,
President Iron Moulders' Union of America.

FRANK P. SARGENT,
Grand Master Brotherhood of Locomotive Firemen.

HENRY WHITE,
General Secretary United Garment Workers of America.

JAMES M. LYNCH,
President International Typographical Union.

The signers of the above appeal were appointed by the chairman of the conference, Hon. Franklin MacVeagh, as a committee to carry out the recommendations of the above report.

MISTAKEN SECRECY.

IN concluding his excellent article on Cyaniding Mill Tailings on page 299 of this issue of MINES AND MINERALS, Mr. Magenau endorses remarks we have frequently made in these columns as to the mistaken secretive policy adopted by so many technical men in regard to improvements about their plants. He calls attention to the marked contrast in this respect in South Africa where the Chemical and Metallurgical Society has greatly aided the development of the metallurgical industry by the encouragement it has given to the publication of original work.

The facilities for making public the results of researches, and even of daily practice, are not lacking in this country, and the transactions of the various technical societies and the technical

press are open to just such material as Mr. Magenau suggests. A desire to be secretive undoubtedly exists in many cases, but with many men in practice it is not so much a desire to withhold information, as it is a real, or apparent, lack of time, or rather lack of inclination. Many feel that they cannot express their ideas on paper with the same ease and skill with which they run a mill or mine, or with the fluency or grace of a Longfellow or Holmes. It is very fortunate that this is true, else the mining fraternity would be robbed of its best talent for the benefit of the literary world. Every man in practice can tell what he is doing or has done, and it is the business of the technical editor to do the polishing and finishing, and he will always attempt to clothe interesting facts in proper dress for presentation to the public, which, after all, is not nearly so critical of how a thing is said as it is of what is said.

Mr. Magenau has set a most excellent example, and we trust many others may be induced to follow it for the benefit of the mining industry.

EXIT D. V. & K. R. R.

IT HAS been apparent for some time past that the gradual absorption of the individual anthracite collieries by the coal-carrying railroads meant the abandonment of the Delaware Valley and Kingston R. R., or as it was commonly called the Individual Operators' Railroad:

In formally announcing this fact the *Anthracite Coal Operators' Letter* for January give the following interesting resume of the various agreements which have been in force between the individual operators and the coal carriers in the past.

It says:

Since the last issue of the letter there have been developments of great moment in the anthracite industry, changes which affect every land owner, mine operator, and employee in the regions, and which, through the railroad interests directly and indirectly involved, have an effect upon the thousands of owners of the various securities of these roads. No industrial movement in this country has ever had such widespread result.

From the beginning of the anthracite mining industry, the individual operators fought against the rates of freight charged by the transport on lines entering the coal regions, and through their efforts to secure relief one after another of the existing anthracite railroads has been built to, or extended into these regions, each one offering something a little better than had previously been given.

In the earlier days of the anthracite industry, there were in only a few individual cases contracts by which the railroads, or the coal companies operated by them, purchased coal from independent operators. The Lehigh Valley and several others had an arbitrary freight rate, which was advanced or decreased as the average price at tide water changed. The Delaware, Lackawanna and Western and the Delaware and Hudson, both of whom handled coal from independent operators, took it on a sliding scale under the labor basis contract. The various contracts and rates of freight netted the operators from 40 to 45 per cent. of the tide price, and less than this in the case of certain competitive points to which the arbitrary freight was charged.

When the New York, Susquehanna and Western was projected into the Wyoming region, its promoters agreed to buy coal from the independent operators and pay 50 per cent. of the tide-water price; but there was a long and hard fight before it was built, and its completion was delayed until 1894, though prior to that time the company had been buying and shipping coal under its contracts.

In 1888, Coxe Brothers & Company, the largest shippers among the individual operators, appealed to the interstate commerce commission against the rate charged against their coal by the Lehigh Valley Railroad company. During the progress of the hearings the railroad company reduced its freight rate slightly. The decision, announced in March, 1891, was that many of the points at issue were outside the scope of the commission, and that the rate then established should not be advanced.

In 1890, the New York, Ontario and Western railway built an extension into the Upper Wyoming region after securing a guarantee of sufficient tonnage, offering to transport the coal for 40 per cent. of the tide price and later agreeing to buy the output and pay 55 per cent. of the f. o. b. price. Other railroads gradually made a similar advance. In 1892, after a series of consultations between the president of the Reading railroad and a committee representing the individual operators, a contract was drawn up giving 60 per cent. of the tide price to the operators, and this was entered into by the various companies then under the control or influence of the Reading.

These contracts extended for seven years and expired in 1899. In 1898, after repeated efforts had been made to secure the promise of their renewal on more favorable terms, each failing any definite result, the individual operators organized the New York, Wyoming and Western Railway company; surveyed a line from the Wyoming region to tidewater; bought several thousand tons of rails; secured right of way; a satisfactory tide terminal, and begun construction. Upon this, negotiations were opened by the railroads, culminating, after nearly a year, in a satisfactory plan, which was begun but not completed. After this, the opportunity occurring, the interests of the operators were consolidated with

the Pennsylvania Coal Company, the bed of the abandoned Delaware and Hudson canal was purchased and the Delaware Valley and Kingston Railway company incorporated.

The contracts upon which this new road was to buy the operators' coal gave to the latter 65 per cent. of the tidewater price, or, in other words, reduced the freight rate from one-half the f. o. b. price, which it was prior to the 1892 contracts, to but little over one-third, beside making even more material concessions in pea coal and the smaller sizes, and giving an opportunity for more days work each year than had been possible under the former arrangement. Under such conditions the operators had hoped to be able to market their coal at a lower price, thus reducing the cost to the public, while receiving themselves the benefit of the increased output.

The existing anthracite companies opposed this new railroad, both by endeavoring to obstruct its right of way, and by a legal fight. But as one after another decision resulted favorably to the new enterprise, it became apparent that other steps were necessary, and these were taken in the purchase of the Pennsylvania Coal Company.

At about the same time as this step was taken, the various coal mining companies controlled by the anthracite transporting lines expressed a willingness to purchase coal from the individual operators, paying the latter 65 per cent. of the selling price at tide water, and several of them increased their holdings in anthracite lands by the purchase of favorably situated collieries.

This practically closes the book. For the new railroad can be said, with Richard I., "Farewell at once; for once, for all, and ever."

TRADE OF UNITED STATES WITH RUSSIA.

CONSUL General F. H. Mason, of Berlin, has recently contributed a very interesting article to the State Department consular reports in the form of a translation of an editorial which appeared in the *Hamburger Fremdenblatt* of December 8, under the heading of "American Danger." We hope to quote this at length at some future time, but for the present the following short extract is of interest:

"American tools enjoy by reason of their excellent qualities the greatest reputation, and in spite of their high prices stand above competition in nearly the whole world. Also in sewing machines, bicycles, and agricultural implements of every kind the United States has begun to drive England and Germany from the world's markets, especially that of Russia."

During the year 1899, we exported to Russia manufactured goods amounting to \$10,000,000, and for the first ten months of 1900 manufactured products of about the same value. These figures apply only to goods sold direct and going into Russia by way of the Baltic and Black Sea ports, and do not include the large amount of goods imported to Russia via England and Germany. The completion of the Trans-Siberian system will open up a large new field for American machinery of all kinds, and under our present treaty arrangements with Russia all articles manufactured in the United States are admitted free of duty to the port of Vladivostock and other Asiatic ports of Siberia and Russia.

At the present time a small amount of sugar is imported into this country from Russia, the total value of these imports for 1899 being \$340,000, and for the first 11 months of 1900 the total value was less than \$355,000.

It is reported that the beet sugar interests of the United States aim to prevent this importation of sugar from Russia by having the Secretary of the Treasury abrogate the clause in our present reciprocal arrangements with Russia by which such sugar is brought into the country under the favored nation rate of duty. This would prohibit further imports of sugar from Russia, and would probably be promptly met with retaliation by the Russian government, which very naturally would increase the duty on American manufactured goods, possibly to a prohibitive point, thus leaving in the lurch a great number of American manufacturers with half-completed contracts in hand made under existing tariff conditions.

While the beet sugar industry is entitled to its share of protection, it would seem to be suicidal policy to cut off a constantly growing export trade, which now amounts to over \$10,000,000 per year, and with a very bright prospect for it, for the sake of a very weak competition for the sugar industry which amounts to only a few hundred thousand dollars per year.

Book Review.

REPORT OF THE MINING INDUSTRY OF NATAL FOR THE YEAR 1899. By C. J. Gray, A. R. S. M., Commissioner of Mines, Natal. Petermaritzburg. 70 pages.

THIRD BIENNIAL REPORT OF THE INSPECTORS OF MINES OF ALABAMA. J. de B. Hooper, Chief Mine Inspector, Birmingham, Ala. 70 pages and tables.

TRANSACTIONS OF THE NEW SOUTH WALES CHAMBER OF MINES, November, 1900. This number is devoted to "Notes on Explosives used in Metal Mining." 8 pages.

ALLEGEMEINER BERGMANNSTAG IN TEPLITZ, 1899. Festbericht und Verhandlungen. Vereine für die bergbaulichen Interessen im nordwestlichen Böhmen zu Teplitz. Gottfried Huttemann, Vereinsobmann. 251 pages.

GEOGRAPHY OF THE REGION ABOUT DEVIL'S LAKE AND THE DALLES OF THE WISCONSIN, by R. D. Salisbury, A. M., and W. W. Atwood, B. S. Bulletin No. V of the Wisconsin Geological and Natural History Survey, Madison, Wis. 151 pages.

ANNUAL REPORT OF THE INSPECTOR OF MINES OF MARQUETTE COUNTY, MICHIGAN, September, 30, 1899, to September 30, 1900. James Tregonning, Inspector of Mines, Marquette, Mich. This contains a statement of the accidents in the mines during the period in question.

TATE'S MINING, Including Mining Arithmetic, Examples for Mining Students, and the Theory and Practice of Mine Ventilation, by William Tate. Published at the Office of The Science and Art of Mining, Rowbottom Square, Wallgate, Wigan, England.

EXTRACTS FROM THE TWENTY-FIRST ANNUAL REPORT OF THE U. S. GEOLOGICAL SURVEY, David T. Day, Chief of the Division of Mining and Mineral Industry, Washington, D. C. The Stone Industry for 1899, by William C. Day. 32 pages. Production of Fuller's Earth for 1899, 6 pages. Production of Quicksilver for 1899, by E. W. Parker. 15 pages.

UNITED STATES GEOLOGICAL SURVEY. Charles D. Walcott, Director, Washington, D. C. Part I.—Twentieth Annual Report for 1898-99. Part II.—General Geology and Paleontology. Part III.—Precious Metal Mining Districts. Part IV.—Hydrography. Part V.—Forest Reserves with Maps. Part VII.—Explorations in Alaska in 1898.

REPORT OF THE BUREAU OF MINES OF ONTARIO. Archibald Blue, Director, Toronto. 239 pages, illustrated. This report contains the following papers: Mineral Industries of Ontario; Mines of Northwestern Ontario; Mines of Eastern Ontario; Michipicoten Mining Division; Niven's Base Line; Copper and Iron Regions of Ontario; Minerals of Ontario, with Notes; A Sketch of the Nickel Industry; The Mines Law of Ontario.

EXTRACTS FROM THE TRANSACTIONS OF THE INSTITUTION OF MINING ENGINEERS OF GREAT BRITAIN. Water-softening plant at Langwith Colliery by J. G. Shearer. Safety-Lamp Cabin at Heworth Colliery, by Thomas V. Simpson; Underground Electric Haulage at Manvers Main Colliery, by Arthur T. Thomson; Weight of Winding-Drums for Deep Shafts, by Daniel Burns; Hydraulic Cage-Loading and Unloading Apparatus at Cadeby Colliery by G. B. Stones.

ANNUAL REPORT OF THE INSPECTOR OF MINES OF THE TERRITORY OF NEW MEXICO for the year ending June 30, 1900. J. W. Fleming, Inspector, Silver City, New Mex. 54 pages. Published by the Secretary of the Interior, Washington, D. C. The report contains a somewhat detailed description of each mine in the State, together with numerous excellent photographs of mine head works, together with a number of sections of coal measures in the Territory.

ANNUAL MINING REPORT OF THE DEPARTMENT OF MINES AND AGRICULTURE, New South Wales, for the year 1899. Hon. J. L. Fegan, Esq., Minister for Mines and Agriculture, Sydney, N. S. Wales. 231 pages. This report contains detailed reports upon the principal minerals and the mineral products for the year 1899; also the reports of inspectors of mines and superintendents of diamond drills, government geologists, surveyors, assayers, and other officials.

ANNUAL REPORT OF THE MINE INSPECTOR OF INDIAN TERRITORY for the year ending June 30, 1900. L. W. Bryan, Mine Inspector, South McAlester, Ind. Ty. Published by the Secretary of the Interior, Washington, D. C. 70 pages. The inspector notes an increase of about 35% in output, and also an increase in the number of accidents. Each mine in the territory is described briefly, and the large number of photographs add greatly to the interest. The scales of wages and the rules and regulations of a number of the companies are of interest.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR 1899. Washington, D. C. 713 pages. In addition to the usual departmental reports this volume contains a number of interesting and valuable statistical papers which are of unusual popular interest, as will be shown by the following, which are a few of the

subjects taken up: The Function of Large Telescopes, by George E. Hale; The Chemistry of Stars, by Norman Lockyer; Progress in Color Photography, by G. H. Niewenglowksi; Scientific Ballooning, by J. M. Bacon; The Excavations of Carthage, by Philip Berger, &c., &c.

NEW ZEALAND PAPERS AND REPORTS RELATING TO MINERALS AND MINING, by Hon. James McGowan, Minister of Mines, Wellington, N. Z. This report includes statements of production and similar statistics, papers on the gold fields of New Zealand, reports of the inspection of coal mines, and examination questions given for mine managers and stamp superintendents, a description of the Pungonga and Pakawau coal fields, and a paper on the geology of the Coromandel gold fields. Gold dredging and gold mining naturally occupy a prominent position in the report, and particularly interesting information is given along these lines.

NOTES ON SOME EUROPEAN IRON MAKING DISTRICTS. A collection of letters to the *Iron Age*, New York City, by Charles Kirchhoff during a visit to Europe in the spring and summer of 1900 to study the Paris Exposition. Those who have followed Mr. Kirchhoff's interesting articles in the *Iron Age* will be very glad to have them in this permanent form. These papers include the following subjects: The Iron Industries of Germany; The Minette District of Lorraine, Luxemburg and France; Glimpses of the British Iron Industry; The German Machine Tool Market; A Flying Trip to Remscheid; Paternalism and Industrial Development. 113 pages.

JOURNAL OF CENTRAL MINING INSTITUTE OF WESTERN PENNSYLVANIA, Volume I. F. C. Keighley, Editor, Uniontown, Pa. This contains the greater number of papers presented before this Institute since the beginning 1899, and the Institute is to be congratulated upon having finally put into permanent form some of the excellent papers presented before it. It is to be regretted that this could not have begun years ago, but it is to be hoped that now that a beginning has been made it may be continued from year to year. In addition to the text matter the Journal contains a number of full page photographs of the mine inspectors of the bituminous districts of Pennsylvania, the authors of some of the papers, and the officers of the Institute, together with a frontispiece photograph of Mr. Roger Hartley, for years treasurer of the Mining Institute of Western Pennsylvania, to whom the journal is dedicated.

PRACTICAL COAL MINING. A Manual for Managers, Under-Managers, Colliery Engineers, and Others. By George L. Kerr, M. E., M. Inst. Min. E., Colliery Manager. Published by Charles Griffin & Company, Ltd., and the J. B. Lippincott Company, Philadelphia, Pa. 462 pages. Price \$4.00. The scope of the book is best shown by the chapter headings, which are as follows: The Sources and Nature of Coal; The Search for Coal; Sinking; Explosives; Mechanical Wedges, Rock Drills, and Coal-Cutting Machines; Transmission of Power; Modes of Working; Timbering Roadways; Winding Coal; Haulage; Pumping; Ventilation; Safety Lamps; Surface Arrangements, Coal Cleaning, Etc.; Surveying, Leveling, and Plans. The illustrations are copious, well selected, fairly clear and serve to explain the text. The author has evidently consulted a large amount of contemporary literature, and has adapted data from a large number of sources, in every case giving full credit to the original source. His plan of presentation is pleasing, and he has given us a useful book. Under the heading of Coal-Cutting Machines, he might, with advantage, have treated American practice more fully, as such machines have certainly been most highly developed and perfected in this country. The book is, of course, written from the English standpoint, and as it is probably intended for Englishmen the author cannot be criticised too severely for not being abreast of American practice. The book will compare very favorably with similar English text books, such as Lupton's and Hughes', but the time is past when it is possible within the limit of a single book to attempt to satisfactorily treat the whole subject of coal mining, and it is hoped that future authors instead of grappling the whole problem will take up portions of it and give us comprehensive texts upon each portion. There is ample material and scope for any one author for comprehensive books upon methods of working, haulage, ventilation, etc. It strikes an American very peculiarly to be told that the miner's dial or compass is still the principle surveying instrument for use in coal mines, as this practice was obsolete with us several generations ago.

THE COAL AND METAL MINERS' POCKETBOOK. Sixth Edition. Published by The Colliery Engineer Company, Scranton, Pa. Size 4½ by 6½ inches. Bound in leather. 635 pages. Price \$3.00.

This book may be divided into three portions. First, a preliminary portion of 235 pages. Second, a portion of 218 pages devoted to practical mining and the preparation of coal and ores. Third, 200 pages of tables and glossary.

The first 130 pages, including the subjects Weights and Measures, Elementary Mathematics, Surface, Underground and Stadia Surveying, Mechanics, Strength of Material, and Wire Ropes,

closely resembles the Fifth Edition of the Pocketbook, but through changes in arrangement these subjects are presented in a more logical sequence. In this portion the tables for converting metric into the customary measures, and vice versa, the sections on the use of the solar attachment to the transit, trigonometrical leveling, metal mine surveying, railroad curves, a diagram giving the proper working load on a wire rope, a new rapid method of rope splicing, and a section on lubrication are some of the noticeable and valuable additions over the previous addition.

The section on Hydraulics and Pumping Machinery—31 pages—is new, and while it has not been possible to treat the subject exhaustively within the limits assigned to it, the tables and formulas given are the essential ones for the mining man.

Fuels, Boilers, the Steam Engine, and Compressed Air are treated in 37 pages, and while the essential and most useful data are given, it is to be regretted that more space could not be devoted to these important topics. We appreciate the fact, however, that the task of selecting from the large amount of data available on these subjects is not an easy one.

Electricity is most excellently treated in 32 pages. The method of presentation includes a very clear explanation of the common electrical terms, such as two-phase, multiphase, alternate currents, etc., while the general electrical principles underlying motors, dynamos, etc., are very clearly expressed. This section of the book deserves special commendation, and it should fill a want among mining men.

Prospecting and Opening a Mine are treated with a fair degree of fullness in 30 pages. The section on Drilling is a useful one, and the costs given are valuable. The diagram for reporting on mineral lands has been greatly enlarged over the previous edition, and while few engineers will probably use it in its entirety, it will serve as a good suggestive outline for a comprehensive report.

Mine Timbering is described by 49 illustrations with descriptive text. These show the typical forms in use, and although but 12 pages are given to this important subject, a great deal of information has been put into this small compass by the method of presentation adopted.

Methods of Working occupy 51 pages, and an improvement is noted over the previous edition, in that American practice is described and examples are not drawn from antiquated English methods. Under the heading of Open Work, cableways, steam shovels, placer, dredge mining, etc., are briefly treated. The general principles of underground work are given, followed by a comprehensive section on mine pillars. Typical room and pillar and longwall are described and modifications of these types, as they have been worked out in various sections of the United States, are described; all copiously illustrated. The ordinary stope mining of the mineral deposits is concisely covered, while the somewhat local methods applied to the large bedded deposits in the Lake Superior region are well given.

Ventilation of Mines, including mine gases, is clearly given, and the tabular method of presenting the formulas is particularly useful. The formulas for splitting the air are entirely new and are useful additions. This section of the book might have been condensed into somewhat smaller compass, but its great importance in connection with coal mining probably warrants the editors of the book in assigning it the space allowed to it.

Haulage and Hoisting are clearly presented by a series of problems worked out for the various conditions which will arise under rope and motor haulage. The calculations of the compressed air and the electric haulage plants, in connection with the sections on compressed air and electricity given in the previous part of the book, should be very useful.

Ore Dressing and the Preparation of Coal occupy 32 pages, and while a large amount of interesting data have been collected, this section of the book will stand considerable amplification. It is really a subject by itself and almost worthy of a separate pocketbook, and while the information given is well presented and useful, it is suggestive of a great deal more that might be included.

The third portion of the book includes useful tables of logarithms, trigonometric functions, etc., very clearly printed. The glossary is probably the most complete ever published.

The typographical appearance of the Pocketbook is excellent. The illustrations are clear, well chosen, and not too numerous. The tables seem to have been revised and have been brought closely up-to-date. It would be an easy matter to suggest other matter that might have been included with advantage, but probably no one appreciates this better than the authors of the book, and in examining such a book it must be criticized for what it contains rather than for what it does not contain.

We regard the new edition of the Coal and Metal Miners' Pocketbook one of which the publishers may well be proud. The practical man or engineer who possesses it has a cyclopedia of useful information superior to any similar publication in the mining line in the English language.

Scranton, Pa.

WM. GRIFFITH, Mining Engineer.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Rutile.

Editor Mines and Minerals:

SIR:—What are the uses of rutile? What is its market value? And how extensive is the demand.
Lowesville, Va. G. W. SMITH.

Rutile ore is used in connection with porcelain painting, and also in giving the proper shade of color and enameled appearance to artificial teeth. The demand for it is limited. In 1899, according to the U. S. Geological Survey reports, 230 pounds were marketed, the value of which was \$1,030.

Entries Approaching Abandoned Workings.

Editor Mines and Minerals:

SIR:—Can you refer me to any works or articles that will help me in opening a mine which when opened will be in close proximity to an old mine that has been worked out and abandoned 12 years ago? What I want particularly on this subject is something that will act as a guide in approaching these old workings.
F. F. T., Massillon, Ohio.

Consult following articles in MINES AND MINERALS, "Dangers From Old Workings," page 90, September, 1899; also "Precautions Necessary When Mine Entries Are Approaching Abandoned Workings," page 236, December, 1899; also see the answer to Ques. 41, page 274, January, 1900.

Grades of Steam Lines.

Editor Mines and Minerals:

SIR:—I have recently seen some reference in Pamey's Handbook in regard to using a horizontal steam line. I would like to know if a steam line leading from a nest of boilers to the engine should not be erected with a certain grade; and if so, what should be the grade and in what direction should the steam line drain? In the erection of a steam plant recently, we arranged to carry the exhaust steam from our compressors back to the boiler house where it enters a feed water heater, and from thence passes to the boilers. Should this exhaust steam line have a grade, and should it be the same as for the steam supply pipe?

Thomas, W. Va.

J. F. H.

The reference to a horizontal steam line in Pamey's Handbook probably relates only to that portion of the steam line above the boilers as being horizontal. All steam lines, whether for live or exhaust steam, should have a sufficient grade to insure their drainage; the steam pipe for live steam supplying the engines should be given a fall of, say one foot per hundred feet, from the engine and toward the separator boilers. The grade of the exhaust steam line does not require to be as great as that carrying the live steam, as the drainage of the former is in the same direction in which the steam is passing, the flow of the steam in the pipe assisting the drainage instead of opposing it as in the case of the live steam pipe. The exhaust pipe should be given a fall of 6 inches per hundred feet from the engine toward the feed water heater.

Hardening Steel.

Editor Mines and Minerals:

SIR:—1. How is steel case hardened?
2. How must I proceed to harden soft steel in potash, and will this process temper the steel and make it fit for "cutting tools."
Yours, etc., CHARLEY STORCH.
Republic, Washington.

Iron is case hardened by packing it with carbonaceous matter, such as charcoal, charred leather, or some similar compound, in cast-iron boxes. Covers are sealed onto the boxes with clay and the whole brought to a red heat and kept there for some time. Carbon will strike into the surface of the iron, making steel of it. After the proper treatment, the box is removed and the hot contents poured into water which will harden the surface. This process is applied both to wrought iron and low

carbon steel. High carbon steel does not require case hardening. When soft steel or iron are hardened by means of potash or potassium cyanide, the metal is heated to a dull red heat, the cyanide rubbed or sprinkled over its surface, the metal returned to the fire, brought to the proper temperature and then plunged into water. This will harden the surface, but it will rarely if ever extend to any great depth. Potash hardening by this method is not suitable for making cutting tools and as a rule no case hardening process is used for this purpose, though milling cutters have been made from mild steel and case hardened very successfully, but such work is usually done by packing the carbonaceous material and treating as described above.

Method of Opening a Coal Seam.

Editor Mines and Minerals:

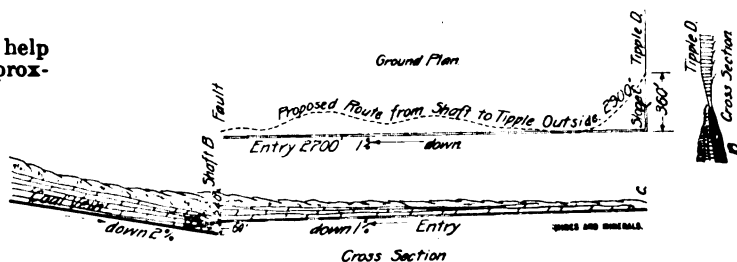
SIR:—A question has arisen over the method of opening a certain basin of coal for mining. I would like to have the two propositions put before your correspondents, in order to hear their practical opinions.

The sketch shows the ground plan, the old entry is 2,700' long with 1% grade against the loads. The old slope C is 360 feet long and 18° pitch up to the tippie.

In order to maintain the output a basin of coal has to be opened for mining, which is on the east side of a fault and has been found to be a downthrow of 60 feet.

The propositions are:

First, to sink a 240-ft. shaft B near the fault on the outside



and hoist the coal to the surface and from there by tram road convey it to the tippie D. Size of shaft 12 ft. × 24 ft. and it can be used also for ventilation and pumping.

Second, To sink a 194-ft. long slope at 18°, size 6 ft. × 24 ft. at the face of the old entry to the coal. The coal mined can be conveyed up the new slope through the old entry by rope haulage to the foot of the old slope C, from where the coal is hoisted to the tippie D.

Points to consider:

The mine and the overlying rocks contain a good deal of water, which contains sulphurous acid.

The ventilating machinery for the old mine, which will stay in operation, has reached its maximum.

The foot of the old slope C is also the landing place for coal from other points of the old mine. More coal could be handled on the tippie D than the present output.

Which of the two propositions is the better?

Brookwood, Ala.

L. A. O. GABANY.

Drainage.

Editor Mines and Minerals:

SIR:—There is a fall of 32 feet between the mouth of our drift and the bottom of a swamp containing water. The drift is 1,600 feet long. Which is the best place to put a pump to drain the swamp.

Suterville, Pa.

W. H. LANDER.

M. E., or E. M.?

Editor Mines and Minerals:

SIR:—What is the proper abbreviation for Mining Engineer, M. E. or E. M.? Yours, etc., J. E. HANIQUE, Pine, Idaho.

Both of these are used, by mining engineers, although it is generally considered that M. E. is the contraction for Mechanical Engineer, and E. M. the proper for Engineer of Mines.

"Whalebacks."

Editor Mines and Minerals:

SIR:—In MINES AND MINERALS for November, 1900, page 162, editorial "The World's Mineral Production" you use the following:

"The problem of the transportation of iron ores * * * * * was solved by the invention of the whaleback," &c., &c."

If you will examine into this whaleback question you will develop the following situation: The whaleback costs more to build than ordinary mode of ship construction, does not carry freight any cheaper and is of no advantage as a type over the

older form of ship construction. The whaleback idea is exploded and no more are being built, and no more will be built.

Detroit, Mich.

JOHN RODES.

The statement to which Mr. Rodés refers was not intended to mean that the "whaleback" had proven a permanent solution to the transportation problem but it was used somewhat figuratively to show that a transportation problem had been met and quickly, even though temporarily, solved by the inventive genius of our engineers. Since, however, our meaning was open to misconstruction we are greatly indebted to Mr. Rodés for calling attention to the matter.

The following from a letter recently received from a prominent engineer of Cleveland, Ohio, is of interest as bearing on this same point. He says: "The modern lake vessel is the old pattern enlarged and improved by steel construction and is a much better carrier than the whaleback. The whaleback is of small capacity, small hatches and outside of use as an ore carrier is not adapted to the general run of lake freight, and I believe there have been no new boats built on that plan for several years."

Design of a Ventilating Fan.

Editor Mines and Minerals:

SIR:—I recently observed a fan in course of construction, which was to be used as a ventilating fan for one of our mines. The machine in question is to be 18 feet in diameter, and coupled direct to the engine. There are to be 14 blades, each 6 feet long by 5 feet wide. The fan will have two intake openings 6 feet in diameter, one upon each side. The blades are to be supported by three solid cast iron spiders three feet in diameter, and will be curved instead of straight.

It appears to me that the intake area of this fan is too small, since after deducting the area of the spiders, the opening upon each side is only a little over 21 square feet; and this area will be still further diminished by the braces and the timbers supporting the shaft of the fan. It also seems to me that the number of the blades is larger than necessary, and their width excessive. I would prefer also that they should be straight instead of curved. The only reason by which I can account for the existence of the curved blade in mine ventilators is that by their use the shock to the fan, occurring at the point of cut-off, is materially lessened. I believe that straight paddle blades will give greater efficiency and will not subject the machine to any greater strain, if the cut-off instead of being parallel to the blade tips is arranged in a V shape. If I were to build the fan in question, I should prefer to make the intake openings 7 feet in diameter, and to have 10 straight blades 5 ft. 6 in. long and 3 ft. 6 in. wide, and use two spiders instead of three. It appears to me that the great width of the fan blades, in this case, adds only to the weight and bulkiness of the machine and increases the cost of installation, without appreciably increasing the efficiency of the fan. It is my experience that wide fans, as commonly constructed, do not fill up with air as completely as narrow ones, while their speed limit is less. If you can spare the time, and feel so disposed, you will confer a favor by informing me if better results may not be anticipated by constructing the fan in accordance with these suggestions, instead of upon the plan proposed.

Very truly yours,

JOHN VERNER,

Oskaloosa, Iowa.

State Mine Inspector, 2nd Dist.

The criticisms offered are in the main very good. The intake opening of this fan appears somewhat contracted. The whole matter, however, depends upon the service for which the fan is intended; that is to say, the conditions under which it is to perform its work. If we assume a circulation for which the fan is probably intended, of 50,000 cubic feet of air, passing under a 2-inch watergauge (though this watergauge is perhaps a little high), and a sectional area of 50 square feet in the fan drift; giving a velocity of the air-current equal to 1,000 feet per minute, and use these values in the fan formulas given in MINES AND MINERALS, Vol. 20, page 55, we have for the inner diameter of blades, $d = 6.6$ ft. Our correspondent suggests that the diameter of this intake opening, should be 7 feet. In regard to the width of the blade we have been accustomed to assume that it should be sufficient to make the area of the throat of the fan (which is the cylindrical surface corresponding to the diameter of the intake opening and extending across the fan) slightly greater than the total intake area. Assuming the same data as above and employing the same set of formulas, we calculate this width to be 4.1 ft. Our correspondent suggests that the width should be 3' 6", which may be correct, if the conditions we have assumed do not agree with the actual fact. We believe, however, that 3' 6" would be somewhat narrow for the width; as we have already taken a rather high watergauge (2 inches); the higher the watergauge the narrower the fan should be for the same diameter.

The number of blades proposed for this fan (14 blades) is undoubtedly too large, as this would give an angle between the blades of only 26° and make the distance between the tips of the blades but slightly greater than 4 feet. Our rule has been to make the number of blades in the fan such that the distance between the blade tips at the circumference would not be greater than the depth of the blade.

The suggestion in regard to the form of the blades will be regarded by many as too radical. While it is true theoretically that the curvature of the blades decreases the centrifugal force developed in the machine at any given speed of turning; yet, the results in practice show that fans having curved blades are as efficient within limits which are appreciable, as those having straight paddle blades; the only difference between the two types being that the former require a higher speed of turning than the latter, to produce the same results. The same horsepower applied to the two types of ventilator will produce a higher speed where the blades are curved than where they are straight; but the yield of the fan in each case will be very approximately proportionate to the power applied. In regard to the shock at the point of cut-off being greater where the curved blades are used; this may or may not be true, according to the style of cut-off used. The writer has seen cut-offs that presented a flat surface normal to the circumference of the fan, and that produced a shock upon the air that was communicated to the fan structure, as each blade passed this point. Under these conditions, it might be allowed that the curvature of the blade backward from the direction of motion, presented conditions that would increase the effect of this shock as the blade passed the cut-off. The writer has constructed many of these fans, in which the cut-off presented only a sharp edge of metal running straight across the fan and parallel to the tip; and in no case was there any vibration resulting. There is no objection whatever, and it may be considered as safe practice, to form the edge of the cut-off in the shape of a shallow V, this shape being more conformable to principle than that of the straight edge, which gives an instantaneous cut-off. However, the writer believes that vibration results more from a lack of true proportionment in the parts of the fan, resulting in the re-entry of air, and conflicting air-currents within the blades; and from other causes producing shock to the air-current, such as we mentioned in reference to a flat surface at the cut-off. Fans which have been designed by these formulas are now in use at different points in the British provinces and in Pennsylvania, and the West, and in every case the ventilator is running smoothly and quietly without jar or vibration.

The use of two spiders instead of three, would seem to be adequate for the support of the blades. The best form of support, however, is that which is now being very generally adopted, of constructing two central conical castings, which surround the shaft and are bolted firmly together, securing between them the radial arms which carry the fan blades.

J. T. B.

Metallurgy of Gold.

Editor Mines and Minerals:

SIR:—On Page 108, October, MINES AND MINERALS, in an article on "The Haile Gold Mines," by Prof. Lakes, appears this, "phosphate of sodium is used in the mill to keep the quicksilver bright and lively." I am a practical mine manager and mill man, have used metallic sodium to assist amalgamation, but I don't know what part phosphorus plays in the use of phosphate of sodium with the mercury. Therefore, I ask the following questions: What action does phosphate of sodium have on quicksilver? How is it used? That is, is it used (after combining with mercury) as clean quicksilver or sodium amalgam is used in milling? Is it necessary to make it of stick phosphorus and metallic sodium, both of which are expensive, or will commercial sodium phosphate (which is $2\frac{1}{2}$ cents per lb. wholesale in New York) answer? Does water have the same effect on the combination (of phosphate of sodium and quicksilver) that it does on sodium amalgam?

Boise, Idaho.

In answer to the inquiries contained in the above letter Mr. Adolph Thies, of the Haile Gold Mining Co., writes:

"Yours of 20th with questions as to the merits of phosphate of sodium over quicksilver, to hand, and in reply beg to say that several years ago a package of phosphate of sodium (commercial) was sent to me for a trial on quicksilver and the trial resulted very favorably in the coalescing of the finest floured quicksilver. I have, therefore, used it for that purpose alone. A pinch of it kept on the quicksilver, used in the mills, keeps it bright and lively, due undoubtedly to its disoxidizing qualities. It does not form any combination with quicksilver like metallic sodium."

Dredging for Gold.

Editor Mines and Minerals:

SIR:—Assuming that all articles appearing in your valuable paper are inserted for the purpose of instructing and enlightening

your readers in regard to the subject with which the article may deal, and not for the purpose of advertising the machinery or other article manufactured and sold by any one firm, I now take the liberty of drawing attention to several small discrepancies and inaccuracies contained in an article appearing in your valuable issue of December entitled "Dredging for Gold," and written by Mr. W. S. Russell, Chief Engineer of the Vulcan Iron Works of Toledo. The writer of the article in question is not satisfied with merely eulogizing the particular dredge manufactured by the Vulcan Iron Works Co., but must needs also criticize and disparage all other types of dredges not manufactured by that company, particularly the Risdon Continuous Bucket Dredge. For instance to quote from the article:—"The Boston and Idaho Gold Dredging Co., of Boston, Mass., has operated a California dredge at Idaho City for the past two years, having met with good success, after the first few months of trial, in 20 ft. ground. They have a small Risdon elevator dredge which does fairly well, as the gravel is small and easy to dig, with a large proportion of sand." Those unacquainted with the merits of the Risdon dredge would gather from the above that it was a mere toy, capable of operating more or less successfully in ground where the gravel is shallow and easy to dig and when all other conditions are favorable, but not to be in any way taken seriously or considered as an up to date dredge. The strongest evidence that this is incorrect lies in the fact that companies operating the Risdon dredge have in almost every case duplicated their order.

Again to quote from the article:—"There are about fifteen dredges working in California, up the Sacramento Valley, from Folsom, on the Feather River, northward, including the Yuba River, Poker Bar, and Trinity River. At or near Oroville, there are seven dredges, of which five are elevator and two bucket dredges. Most of these are small, of the Risdon type, with buckets of three cubic feet size and 1,000 cu. yds. daily capacity." As a matter of fact there are now nine dredges operating near Oroville six of which are Risdon dredges, three of them having buckets of 5 cubic feet capacity and three of them 3½ cubic feet bucket capacity, none of them however being as small as suggested by Mr. Russell. The 3½ foot bucket dredges are handling over 1,000 yards actual bank measurement or 1,500 yards tailings measurement per day and the five-foot dredges over 2,000 yards bank or 3,000 tailings measurement at a cost of less than 3½ cents per yard. Again to quote from the article:—

"It has become evident to all the dredge companies that their machinery is too light and improperly proportioned, and that there is a great expense in making repairs, as the dredges in most all cases are in remote places a long distance from any railroad. In view of this and many other facts, it is evident that there is a necessity for improvements in elevator bucket dredge machinery." This is perfectly true to a certain extent, and necessarily must be so when a dredge is designed by theory, but when the design is governed by long practical experience, as in the case of the Risdon dredge the difficulty is to a large extent overcome: as evidence of this I may point out that the repairs on the dredge owned and operated near Oroville by the Kia Oro Gold Dredging Co. since April 15th, 1889, amount to only \$3,001.84 or about \$150.00 per month (the dredge is now as good as new in every respect) and during this time 380,594 cubic yards of ground bank measurement have been handled. The dredge was closed down for two months whilst changing from steam to electric power otherwise it has been operating continuously.

New Zealand is the banner gold dredging country of the world and there, after experimenting with every type and make of dredge for the last 35 years, all types have been discarded in favor of a type very similar to that designed by the Risdon Iron Works. In one district alone in New Zealand on a river far swifter and rougher than any river in this country upon which dredges are now working there are at the present time ninety-three dredges operating successfully; this in itself is a sufficient answer to the criticism that the Risdon type can only operate successfully under very favorable conditions.

Again to quote from the article:—"Profits in elevator dredging depend on the richness of the ground and economy in operation. A dredge handling 2,000 cu. yds. per day of 24 hours at \$1 per yard will earn \$2,000. There is a big profit in 50c. ground and a good profit in 25c. ground, which would yield \$500.00 per day. There is plenty of 25c. ground in the West, not being worked at all." I have traveled throughout almost every mining district in the West looking for 50c. dredging ground, but so far have failed to find any, with the exception of one or two small patches which have been already taken up. I have frequently examined ground which was reported to be 50c. ground but which prospecting proved to be in no case higher than 27c. and in some cases as low as 5c., that is to say the average value from surface to bed-rock throughout the property.

I cannot therefore quite agree with Mr. Russell that there is plenty of 25c. ground in the West not yet taken up. If there is I shall be pleased to hear of it as I can place all such land at a very good figure: at the same time I may point out that good profits can be made out of 15c. ground if it be properly handled. I have trespassed upon your valuable space in pointing out the inaccuracies contained in the article referred to chiefly in the interest of stock-holders in companies operating Risdon dredges, as such, if allowed to pass unchallenged, might seriously influence the market price of the stock if and when put upon the market. Thanking you in anticipation,

I am, yours, etc.,

San Francisco, Cal. R. H. POSTLETHWAITE,
Designer of Risdon Dredge.

American Institute of Mining Engineers.

The eightieth meeting of the American Institute of Mining Engineers (being the thirty-first annual meeting) will be held at Richmond, Va., beginning Tuesday evening, February 19, 1901. The Secretary of the Local Committee, to whom all communications concerning arrangements, excursions, hotel-accommodations, etc., should be addressed, is Mr. R. A. Dunlop, Secretary of the Chamber of Commerce, Richmond, Va.

No special railway-rates have been secured for this meeting.

The hotel-headquarters, and the place of the sessions, will be at the Jefferson Hotel.

Apart from its convenience as a place for a winter meeting, Richmond and its vicinity furnish at this time a striking picture of the industrial prosperity and progress of the "New South," no small part of which is founded on the development of Southern mineral resources in ores, fertilizers and fuels. Among the works which will be open to inspection may be named the Old Dominion and the Tredegar Iron Works; the Richmond Locomotive Works; the Trigg shipyards; fertilizer-works; tobacco-factories; the new installation of the Virginia Electrical and Development Company (which will probably be then in operation), etc. Moreover, numerous historical attractions are accessible, including, within the city, the Old St. John's Church; Hollywood Cemetery; the Capitol and Library buildings; Crawford's famous statue of Washington, and other statues and monuments; the rooms of the Virginia Historical Society, the Confederate Museum, and the Valentine Art Museum; and, in the vicinity, the famous battle-fields along the James River, the site of the early settlement at Jamestown, etc.

If a considerable number of members and guests should desire to spend the Sunday after the meeting at Old Point Comfort, and visit the interesting localities in that neighborhood (especially the Soldiers' Home and the Hampton Institute), special arrangements can be made for this supplementary excursion.

The Driving Power of Belts.

Although much attention is given to the economical generation of power, but little regard is frequently paid to its economic transmission from the prime motor to the machinery to be driven. The primary agent in belt-driving is friction; hence to insure the greatest efficiency in a belt-driven system the coefficient of friction between the belt surface and the pulleys upon which it runs should be sufficiently high to insure a good grip of the pulley being obtained without the belt being unduly tight.

As a result of an elaborate series of tests it has been shown by Mr. Charles Hopkinson, Member of the Institute of Civil Engineers of Great Britain, that the Camel Brand, or Reddaway Belting, made by the Rossendale-Reddaway Belting & Hose Co., Newark, N. J., has not only an exceedingly high coefficient of friction, but it has the other very desirable quality of lying close to the surface of the pulley, thus insuring a perfect grip being obtained. These tests showed the Reddaway belts to have a very high modulus of elasticity, giving superior tensile strength. This high tensile strength enables these belts to be reduced in thickness, thus giving a very pliable belt and one which lies very close to the pulley surface, requiring less tension to satisfactorily transmit the power.

One of the points of advantage claimed for this belting is the fact that it has a uniform thickness throughout, and hence a uniform strength at every point. It is also said to successfully resist fumes of chemicals, and to be unaffected by changes of temperature and not to be damaged by water, steam, etc.

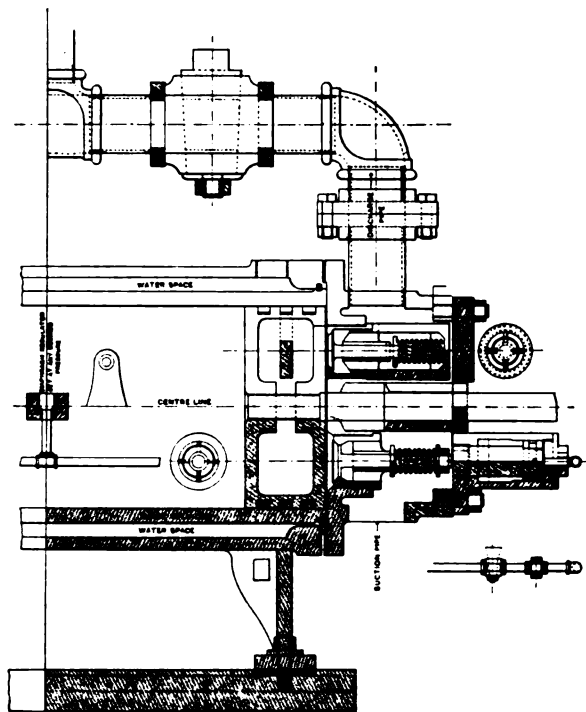
Dolomite Sand.

"Dolomite sand" is a term which we believe originated in Leadville, where certain beds of limestone which contain a high percentage of magnesium carbonate are found in patches or spots to be disintegrated to a sandy condition, so that they may be

penetrated at such places with the pick and shovel, and no explosives are required. Usually—but not always—such disintegrated spots are found to be parts of a water channel, so that the material has all the physical characteristics of a quick-sand and makes great trouble for the miner.—*Mining Reporter*.

The Fisher Air Compressor.

About nearly every mining plant the conditions are such that it is considered good practice to have the engines of considerably greater power than the theoretical conditions call for, so that occasional and unusual conditions may be met without unduly



SECTIONAL ELEVATION THROUGH VALVES.

straining the machinery. This means that under ordinary conditions there is an expenditure of power constantly going on which is practically wasted.

The air compressor built by the Sedgwick-Fisher Company, of 53-55 South Clinton St., Chicago, is so designed that it can utilize some of this otherwise wasted energy. It may be attached tandem fashion to a steam engine, or it may be operated by belt power.

In attaching the compressor tandem, the back cylinder head of the engine is fitted with a stuffing box to receive the piston rod of the compressor, the head is drilled and tapped to attach the two tie rods which hold it firmly in position. The piston rod of the compressor is screwed into the piston of the engine operating in unison and in a direct line. Further, any of the valves may be removed while the compressor is in motion without losing any of the air compressed. This is a decided advantage in case of a slight accident to the most vital parts of any compressor. The receiver pressure is automatically regulated to any desired pressure, which will be maintained, within 2 pounds, up to the capacity of the machine. No air is compressed unless the receiver pressure falls below the point set on the regulator, the result being a saving in fuel.

The capacity of the compressor can be increased or decreased by a simple change in the diameter of the inner cylinder and piston. For instance, if the bore is 5 inches in diameter and the stroke 18 inches, the capacity may be increased by removing the 5-inch cylinder and substituting one that is 10 inches. No change is required in either the valves, cylinder heads or water jacket. This change can be quickly made and at a nominal cost. The valves are of tool steel and the valve seats can be removed and replaced by new ones at any time. Their construction will be understood from the section elevation shown in the figure. Since the compressor is held firmly to the engine by tie rods, no foundation is necessary except enough to carry the weight of the compressor. The air cylinders are thoroughly cooled by water circulating through the jacket. The compressor is so arranged that the free air supply can be piped from the outside of the engine room.

For mining purposes this style of a compressor can be utilized in many instances to a good advantage as there is often surplus

power in maintaining engines sufficient to operate a good sized compressor.

Ordinary hoisting engines can be connected up with a Fisher compressor with good results. The weight of the compressor is about 75% less than any other steam driven compressor on the market of the same capacity, and this is a very essential feature, owing to high freight rate and unfavorable conditions in delivering machinery to mines.

This lightness of weight is also of particular value from a mining standpoint, as it permits the installation of a compressor at an isolated location where the weight of the ordinary compressor is prohibitive to its use.

The compressor described in this article, is 10" bore and 24" stroke, running 100 revolutions, has a capacity of 200 cubic ft. per minute and weighs 1000 pounds. In dismantling it, the heaviest piece will not weigh more than 400 lbs. making it easy to deliver by team or otherwise.

Low Water Alarm.

The Crane Low Water Alarm was originally made by Crane Co., Chicago, some ten years ago, was considered sufficient to meet all requirements.

A comparatively short time ago some of the States enacted a law, stipulating that low water alarms "shall be of a type capable of being tested by the inspector of workshops and factories."

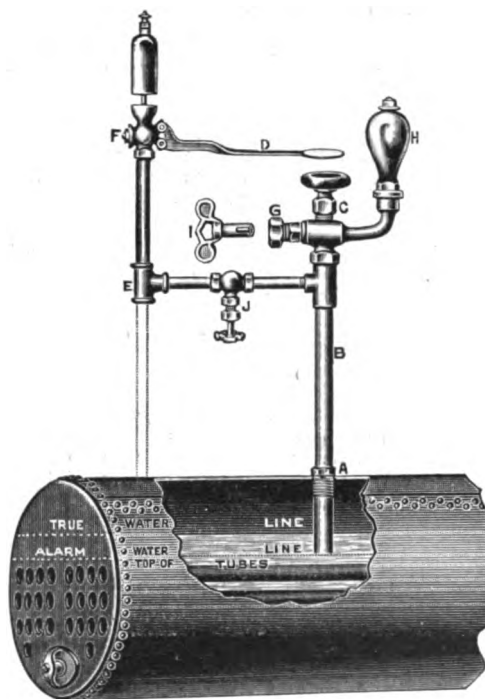
It was, therefore, necessary that an additional valve, with pipe and fittings, be used, thereby enabling the inspector to make a test at any time.

The Crane Patent low water alarm here shown can be attached directly on top of the boiler, or can be piped to any position most convenient to the engineer.

Fusible gaskets are furnished with these alarms that melt at 270 degrees, and gaskets that will melt at a much higher degree are made to order.

To attach the alarm it is only necessary to drill and tap a hole in the top of the boiler of the same size as the bushing A and to screw a short piece of pipe inside this bushing, the pipe being long enough to reach within two inches of top of the boiler tubes. Then connect the tee E by a pipe to any suitable place in the boiler producing live steam.

As long as the water does not go below the low water line, the water in tube B prevents the steam from reaching the fusible plug. The moment the water falls below the low water line, the steam will rush in and fuse the plug C, thereby allowing the



steam to escape through the hole in the wheel, which raises a lever D, opening a valve in the whistle F, thereby allowing steam in pipe E to give the alarm.

To renew the fusible plug, close the valve G, unscrew nut C, and insert new gasket. Then replace nut C, allowing pipe B to cool before opening valve G. Then remove the key I, which indicates that valve G is open and ready for operation again.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for February.

QUES. 652.—Work of a Mule; Maximum Grades in Mule Haulage.—State what you would consider as the proper work of an average mine mule, in ton-miles per hour, in a flat seam. State what you would consider to be the limit or maximum up-grade in mule haulage; also the maximum down-grade where sprags may be safely used.

QUES. 653.—Size of Hoisting Shaft.—State what factors determine the size of a hoisting shaft for a coal mine. What size of shaft would you adopt for the working of a coal seam lying 300 feet below the surface. The seam is 5' 6" thick, and has a good roof and bottom. Assume the output of the mine to be 1,200 tons per day of 10 hours.

QUES. 654.—Retarding Conveyers.—Explain the use and adaptation of retarding conveyers, and what advantages they possess over chutes in the handling of coal.

QUES. 655.—Construction of a Dam for Reservoir.—Describe the construction of a dam across a small ravine, to form a reservoir or water supply for a mine, where the sub-stratum is a sandy loam.

QUES. 656.—Form and Number of Fan Blades.—What in your experience is the best form of fan blade for closed fans. State what determines the number of blades to be used in a fan.

QUES. 657.—Calculation of Size of Fan Required for a Given Circulation.—What size of fan would you employ for the circulation of a volume of 150,000 cubic feet of air per minute against a water-gauge of 2 inches.

QUES. 658.—Adoption of a Haulage System.—What factors should be considered in the adoption of any kind of mine haulage? State also the conditions that would lead you to adopt electric haulage, and give the advantages and disadvantages of this system of haulage.

QUES. 659.—Form and Dimensions of Coke Ovens.—Make a sketch showing the best form of coke ovens, and giving the important dimensions of the same.

Answers to Questions Which Appeared in the December and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 627.—Arrangement of Shaft Bottom.—Describe the arrangement of the tracks, manway, pumps, etc. at the bottom of a shaft 250 feet deep, and making 1,200 gallons of water per hour, the output of the shaft being 1,000 tons per day of 10 hours, and all of the pumping to be done in 4 hours or between shifts morning and evening. Give the size of pump, size of shaft, depth of sump, and length and grade of shaft bottoms. Caging is to be done from both sides of the shaft, and arrangements must be made for cross-caging in case of unequal production. The seam

is 5 feet thick and has a good roof. Give sketch or plan of shaft bottoms, showing tracks, plates, manways, pumps, etc.

Ans.—The hoisting shaft for this output I would make 8 ft. × 12 ft. divided into two compartments by 4 in. buntings, each compartment being 8 ft. × 5 ft. 10 in. inside of cribbing. This shaft will require a separate air shaft, and as there is water to be pumped, provision must be made for pipe lines, and this can best be accomplished in an independent shaft. Hence I would sink a second shaft a suitable distance from the hoisting shaft and having the same dimensions, but divided by an airtight partition so as to form an air compartment 8 ft. × 8 ft., and a manway or pipe way 4 ft. × 8 ft. The latter compartment should be equipped either with cage or ladders and the steam and water pipes should occupy one end of it. I would sink each of these shafts 21 feet below the cage landing at the bottom, thus providing a sump capacity of $21 \times 8 \times 12 \times 2 = 4,032$ cu. ft., which would be ample room for the water accumulating in 24 hours, since $1,200 \times 24 \div 231 \div 1,728 = 3,850$ cu. ft. I would use a double acting duplex horizontal pump, placing it in the cross-cut between the two shafts, which is a narrow entry 8 ft. wide. [The mining law usually fixes the distance between the two shafts.] Since the pumping must all be done in 4 hours out of each 24 we have for the required capacity of the pump $1200 \times 24 \div 4 \times 60 = 120$ gal. per minute. Then, assuming the pump to have a piston speed of 100 feet per minute and allowing 20% for slippage, we have for the diameter of the water end of a duplex pump

$$\sqrt{2 \times \frac{120 \times 231}{.80 \times 100 \times 12 \times .7854}} = 4.29$$
, say 4½ inches, and assuming a steam pressure of 60 lbs. at the pump, and multiplying by ½ to allow for friction and adding the depth of the sump to the depth of the shaft we have for the diameter of the steam end

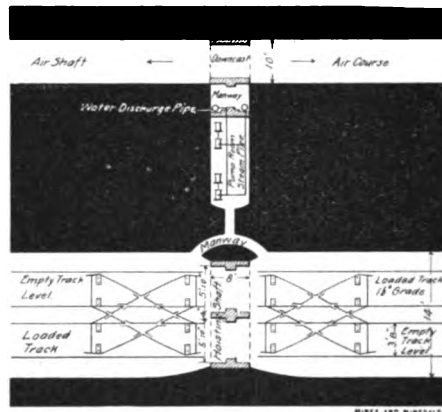
$$4.5 \sqrt{\frac{271 \times .434}{60} \times \frac{3}{2}} = 7.72$$
, say 8 inches. If the stroke is 12 inches each cylinder of the pump will be making 100 strokes per minute. The gauge of the tracks I would make 3' 8"; the switches at the bottom as shown in the diagram will satisfy any extent of cross caging. The shaft bottom I would make 14 feet wide for a distance of 300 feet on each side of the shaft, and extend the double track that length using 30 lb. rails. The grade of these tracks would be 1½% for the first 100 feet next the cage on the loaded side and 1% the next 100 feet, the balance [nearly] level. The empty tracks I would make level for the first 100 feet next the cage, when I would run the grade out to a level with the loaded side at the connection of the empty track with the loaded. The manway I would cut 5 feet wide in the coal around the end of the shaft. The diagram gives an illustration of the general arrangement of the two shafts and the position of manway and pumps.

ROBT. PICKETT, Spring Valley, Ill.

Second Prize.—JOSEPH QUIGLEY, Broad Cove Mines, Cape Breton, N. S.

QUES. 636.—Siphoning from a Shaft.—We have a shaft 50 feet in depth sunk on a hill. The shaft is making 4,000 gallons of water per hour. At a short distance from the mouth of the shaft is a steep ravine that descends to a river 100 feet below the depth of the shaft. It has been suggested that a siphon could be used advantageously to handle this water. If this accords with what you would advise please say so, but if not, state how you would proceed to handle this water if you were placed in charge of the mine.

Ans.—Before a siphon could be used for handling the water from this shaft a tunnel or rock slope would have to be driven from the shaft, at a point not higher than 24 feet above the bottom of the sump, out to the ravine, through which to lay the siphon pipe, since [the theoretical lift of a siphon at sea-level is only 34 feet, and] in practice a siphon will not give good results if the vertical lift exceeds 24 feet, and a shorter lift than this will give better results. It would be far better practice, however, to drive a drainage tunnel from the sump level out to the ravine, and having sufficient dip to provide a good fall for the water.



This last method would prove the more efficient and economical, especially for large quantities of water.

The advisability of tunneling in this case, however, would depend almost wholly on the cost; as the volume of water, 4,000 gallons per hour or $\frac{4,000}{60} = 66\frac{2}{3}$ gallons per minute, is comparatively small and easily handled. Therefore, unless the coal (or other mineral mined) cropped out in the ravine, or the length to be tunneled was very short, resort should be made to pumping. A small duplex, 6" x 6" x 6" pump with a capacity of 200 gallons per minute placed at a convenient distance up the shaft, say from 10 to 20 feet, would lift, in 8 hours, the water that accumulates in 24 hours.

ADOLPHE COOK, Cokeville, Pa.

Second Prize.—PETER WELSH, Ehrenfeld, Penna.

QUES. 637.—*Will Ventilation Cease if Fan is Stopped?*—We have a mine ventilated by means of two shafts, a downcast shaft having a depth of 300 feet, and an upcast shaft whose depth is 500 feet. The ventilator is a blow-down fan, which furnishes a current of 40,000 cubic feet of air per minute in the mine. The development of the mine has been such that the length of its airways from the foot of the downcast to the foot of the upcast shaft is practically 50,000 feet; the double-entry system being used. If the fan is suddenly stopped for repairs will the air current continue to circulate through the mine, or will all circulation in the mine cease?

Ans.—Whether all circulation will cease after the fan is stopped will depend on the difference in density between the air in the upcast and downcast shafts. If the seam is flat, and the difference in depth of the shafts is due to the difference in elevation of the surface, at each shaft, and if we assume the average temperature of the downcast shaft to be 50° F., and that of the upcast 70° F., then, the natural motive column, existing in the shaft and which continues to act after the stoppage of the fan, will be $M = D \times \frac{T-t}{459+T} = 500 \times \frac{70-50}{459+70} = 18.9$ ft. (temp. 50° F.). In doing this we have assumed with very slight error that the air in the downcast shaft had the same average temperature as the outside air. To find the corresponding unit of ventilating pressure we multiply this air-column (temp. 50° F.) by the weight of 1 cubic foot of air at the same temperature and barometric pressure (Bar. = 30"); thus, $\frac{1.3253 \times 30}{459+50} \times 18.9 = 1.4763$ lb. per sq. ft. Now, assuming a 2" water gauge when the current is 40,000 cubic feet [and remembering that the quantity of air in circulation in any given airway is proportional to the square root of the pressure producing the circulation], after the fan is stopped the circulation will be $\sqrt{\frac{1.4763}{2 \times 5.2}} \times 40,000 = 15,071$ cu. ft.

ADOLPHE COOK, Cokeville, Penna.

Second Prize.—PETER WELSH, Ehrenfeld, Penna.

QUES. 638.—*Gob Fires in Abandoned Workings.*—The mine of which I have charge is troubled with gob fires in the abandoned workings near the shaft bottom. The fire walls and brick stoppings which we have used to close off these abandoned workings are only partially effective, and owing to shaly roof and porous character of the coal, sufficient air is still supplied to these abandoned workings to render the fire a constant menace to the mine. The mine is worked on the room and pillar system, with double entries, and is ventilated by means of an exhaust fan. Will you kindly suggest what in your opinion would be the most effectual manner of treating this fire both with respect to the present and future welfare of the mine?

[This important question still remains open.—EDITOR.]

QUES. 639.—*Blasting in Presence of Gas.*—(a) Explain the danger incident to blasting with ordinary black powder in gaseous workings. (b) How is this danger largely overcome in the use of dynamite for blasting? (c) Describe the class of explosives known as flameless powders.

Compare these three forms of explosives and give their relative advantages and disadvantages in blasting coal.

Ans.—The use of ordinary black powder in blasting is always attended to a greater or less extent by the production of dark red flame, which continues for a considerable period, and if any inflammable gas is present or given off in proximity to the blast, it will be ignited by the flame of the explosion. This is especially true in the case of a blown-out or windy shot. In such cases the energy of the blast is expended wholly or partly upon the air, and large, intense flames are projected, which will not only ignite firedamp, but, in a dusty atmosphere, may and often do ignite the dust, distilling combustible carbonic oxide gas (CO), thereby widening the explosive range of the firedamp. Dynamite is much safer for blasting in presence of gas, and should be employed in preference to black powder in gaseous mines. The explosion of dynamite is almost instantaneous, and what flame is

produced lasts but a small fraction of a second, the gases resulting being incombustible. [This time is too short for the ignition of firedamp, which requires to be in contact with flame an appreciable period of time before it will ignite.] The so called flameless explosives (Sprengel explosives) are the highly-nitrated compounds formed by varying mixtures of nitrate of ammonium (NH₄)NO₃ with nitro-naphthalene, nitro-benzol and other nitrates. Examples of these explosives are roborite, securite ammonite etc. It is said they possess the property of suppressing the flame of their explosion, and are therefore considered as safe explosives in presence of gas.

In comparing the merits of these different forms of explosives for blasting coal, we find that black powder, having a slower action, develops its force by degrees and does not crush the coal, but brings it down in larger lumps, but produces much flame that renders its use unsafe in presence of gas. Dynamite and other detonating explosives, do not ignite firedamp mixtures except only in very exceptional cases, and are therefore safer explosives to use in blasting coal, but they shatter and pulverize the coal badly in the region of the charge, as their force is developed almost instantaneously.

ADOLPHE COOK, Cokeville, Pa.

Second Prize.—W. E. PLOWMAN, Valier, Pa.

QUES. 640.—*Effect Of Placing A Regulator, Power Constant.*—A certain fan is maintaining a circulation of 50,000 cubic feet of air in a certain mine in two splits of equal length; split A being 4' x 12', and split B 6' x 12' in cross section and no regulator being used. It is now desired to reduce the quantity of air passing in split B to 20,000 cubic feet by the introduction of a regulator. (a) Assuming that the power upon the air at the point of split remains unchanged, what effect will the placing of this regulator have upon the air passing in the two splits? (b) What effect will the placing of this regulator have upon the speed of the fan?

Ans.—The total quantity of air in circulation is 50,000 cubic feet. This current is traveling in two splits of equal length, split A being 4' x 12' and split B 6' x 12' in sectional area. The relative quantity circulating in each split is as follows:

$$\begin{aligned}\text{Split A, } a\sqrt{\frac{a}{o}} &= 48\sqrt{\frac{48}{32}} = 58.788 \\ \text{Split B, } 72\sqrt{\frac{72}{36}} &= 101.823 \\ &160.611\end{aligned}$$

The actual circulation then is

$$\begin{aligned}\text{Split A, } \frac{58.788}{160.611} \times 50,000 &= 18,301 \text{ cu. ft.} \\ \text{Split B, } \frac{101.823}{160.611} \times 50,000 &= 31,699 \text{ cu. ft.} \\ \text{Total, } &100,000 \text{ cu. ft.}\end{aligned}$$

(a) The effect of placing a regulator will be to increase the resistance and by so doing the total quantity will be reduced. There will be an increase in the volume in split A but the increase will not be as large as the decrease in B. (b) If the same steam be supplied the engine that drives the fan the speed will increase, in consequence of the falling off in the quantity of air passing through the fan.

W. E. PLOWMAN, Valier, Pa.

Second Prize.—ADOLPHE COOK, Cokeville, Pa.

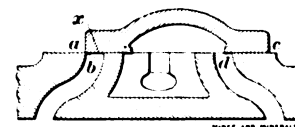
QUES. 641.—*Setting The Valve Of An Engine.*—Describe the manner of setting a valve of an engine. State also in what cases you would use an early cut-off, and give sketch showing the position of the valve at the time of cut-off on the following stroke of the engine.

Ans.—To set the slide valve of an engine,

(1) Find the dead centers by rotating the fly-wheel backwards, having first made a mark on the cross-head, and mark exactly upon the guide bars at the head and crank ends the extreme points of travel of the cross-head mark.

(2) Having removed the steam chest cover, rotate the fly-wheel, now in a forward direction, until the cross-head mark and the head guide bar mark coincide.

Then secure the eccentric on the shaft a little more than a right angle in advance of the crank, if the engine is direct connected, but if the engine is cross-connected place the eccentric a little more than a right angle behind the crank. Then turn the eccentric upon the shaft until the head end a of the valve and the extreme edge b of the head steam port coincide (see sketch). Now, rotate the fly-wheel in a forward direction till the cross-head and crank guide-bar marks coincide and note if in this position the points c and d coincide. If they do, the valve is properly set. If, however, the point c has



passed d , the valve stem must be shortened a length equal to one-half the over-reach; or, if c has not yet reached d and the crank port is still closed, the valve stem must be lengthened an amount equal to one-half the distance lacking to open this port. The valve stem is now of the right length. Rotate the fly-wheel forward until the cross-head and the head guide bar marks again coincide, and once more turn the eccentric on the shaft until the head end a of the valve occupies a position denoted by the dotted line x , when the distance bx will be equal to the required lead. Then fasten the eccentric securely to the shaft, replace the steam chest cover and the valve is set.

In an engine an early cut-off allows the steam to expand and hence more work is obtained from the same amount of steam. In a simple, duplex engine, using steam at a fairly high pressure, an earlier cut-off would be advisable than would be employed in a compound engine. If the steam pressure was very high, however, too much expansion, caused by too early a cut-off, would cause the cylinder to cool too much and would prove a disadvantage.

C. D. WRAY, Lillooet, B. C., Can.

Second Prize.—THEODORE SIMONS, Spokane, Wash.

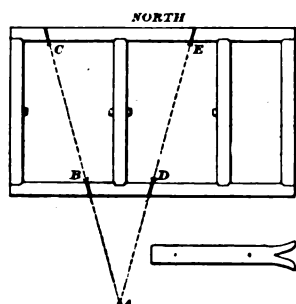
QUES. 642.—*Use Of The Injector For Raising Water From A Shaft.*—We have been using an injector at the bottom of the hoisting shaft in our mine for lifting the water from the sump to the surface. The injector is placed at the height of 8 feet above the level of the water in the sump. The steam is supplied through a 2 inch pipe carried down the shaft. The depth of the shaft is 250 feet. We often experience considerable trouble in starting the injector after it has been idle for a few hours. Will you kindly explain the reason for this difficulty? The trouble seems to be that the injector does not catch the water. Explain the correct position and manner of starting the ordinary Harrison steam injector when used for throwing water from the bottom of the shaft to the surface.

[This is a good practical question relating to the operation of a mine, and we hope will receive the attention of our many practical men. The question is still open.—EDITOR.]

QUES. 643.—*Surveying, Two Plumb Lines In A Hoisting Shaft.*—We have recently sunk a shaft 200 feet in depth to be used as a hoisting shaft. The shaft is 8 feet wide and 18 feet in length, including the pump or manway. Having driven the entries back 100 yards from the foot of the shaft we desire to connect the surface survey with the entry sights below. Describe how this may be done in the most accurate manner possible. The main shaft bottom has a width in clear between timbers of 14 feet; the pump or manway is connected with the air course by means of a cross-cut 7 yards in length; the first breakthrough at the shaft bottom is 25 yards from the foot of the shaft. Give sketch showing position of the plumb lines in the shaft and the manner of connecting the surface and underground surveys so as to give entry sights referred to the same meridian as that used upon the surface.

ANS.—The most accurate method of connecting the surface and underground surveys of a mine is by means of four plumb lines, as follows:

(1) Having located a point A of the surface survey near the shaft, two strings are stretched temporarily from this point to the



opposite side of the shaft curb, for the purpose of placing in line four iron hangers from which the plumb lines are to be suspended. Then, the instrument having been set up at A , the wires are carefully set in line, by means of the transit and the distances AB , AC , AD , AE , BC , DE , BD and CE measured and recorded.

The wires having been set in place are lowered having light plumbbobs attached. The survey party then descends taking with them some planks four buckets of oil and four heavy plumb bobs.

The cage is stopped about 3 or 4 ft. above the bottom and a platform made at the landing on which to place the four buckets of oil. The heavy bobs are then fastened to the wires, and after seeing that the wires hang clear, the bobs are placed in the buckets of oil. When the wires are steady stretch strings from E to D and B to C being careful not to touch the wires. When the bobs have come to rest the distances between the several wires are carefully measured, and if these check the measurements at the surface, the point A is located back in the entry, by measuring the distances BA and DA . Then set up the transit at A and measure the angle BAD and compare this angle with the same angle on the surface. If these do not correspond move the transit slightly forward or back and again check the angle and distances till the required point is found, which will be vertically under the point A on the surface, and the lines

will have the same direction as the surface lines. This method is more accurate than by using two plumb lines only as owing to the narrow width of the shaft the plumb lines would not be sufficiently far apart for an accurate observation to be obtained.

C. D. WRAY, Lillooet, B. C., Can.

Second Prize.—HERVEY HILLS, Cripple Creek, Colo.

[Where they can be used, light sticks with saw-cuts in them fitting the wires at the surface will be found to greatly assist the work below. These sticks are lashed in position between the wires at the shaft bottom, thus converting the four separate bobs into one hanging system and greatly reducing the error due to vibration or swinging.—EDITOR.]

TRADE NOTICES.

The Badger Brass Mfg. Co., of Kenosha, Wis., have just installed a No. 1 special Cross oil filter purchased from the Burt Mfg. Co., of Akron, Ohio.

The Slade Hopkins Mining Machine made by the Erie City Iron Works, Erie, Pa., is specially designed for the working of thin coal seams, and is particularly well worth the study of many men having the difficult task of mining such seams.

The Diamond Drill and Machine Co., of Birdsboro, Pa., has since its establishment in 1869 drilled 170,000 feet or over 32 miles of test holes and well holes, in addition to holes for tunneling and shafting. The largest hole bored was 1 foot in diameter and the deepest 2,352 feet.

The Trenton Iron Company has distributed to its friends an excellent little leather bound pocket diary. This also contains a number of pages of useful and constantly needed information, such as the weather signals, rates of postage, interest laws of the United States, common weights and measures, etc.

The Crane Company, of Chicago, as has been the practice of this firm for some years past, presented each of its employes with a Christmas present equal to five per cent. of his wages for the preceding year. At the St. Louis branch alone about \$2,500 was thus paid out, and as the company has twelve branch houses in the United States, and a pay roll of about 4,000 employes, not less than \$150,000 was probably thus distributed.

At the big mill of the Golden Cochiti Company, Cochiti, New Mexico, the Pelatin-Clerici plant has been torn out and the Pneumatic Cyanide system substituted. The latter is doing excellent work at 60 per cent. less cost than with the first mentioned process. The new Woodbury mill that is building under the management of Mr. W. C. Wynkoop is rapidly nearing completion. It is hoped to start it up during January.

The Sturtevant Engineering Co. has recently moved its London (Eng.) office to 147 Queen Victoria St., that city, in order to secure the increased accommodation necessary for its rapidly growing business as the European representatives of the B. F. Sturtevant Co., of Boston, Mass. A new branch office has been established at 31 Rue de Provence, Paris, and a change made in the location of the Glasgow office to 45 Hope St. The offices at Berlin, Stockholm, Amsterdam and Milan remain the same.

The Jackson Drill & Mfg. Co., of Denver, Col., have cancelled all previous arrangements for selling, that existed between them and the Thornton N. Motley Co., of N. Y., and Mr. H. D. Crippen has been appointed sole licensee and manufacturer, and will hereafter control the sale of the new Jackson Hand Power Rock Drills, for the entire world. Mr. Crippen has offices at No. 52 Broadway, New York City, and also at 1756 Larimer St., Denver, Colorado. The new Jackson Drills, are made entirely of steel, and are guaranteed against breakage for a term of two years.

The three essentials of equipment of every editorial desk are considered to be a blue pencil, the paste pot, and the shears. This fact is always kept in mind by the Dixon Crucible Company, of Jersey City, N. J., which company with unfailing courtesy and most gratifying regularity each Christmas sends us one of its boxes of assorted pencils, crayons, and erasers. The excellence of these materials is too well known to need commenting on, but throughout the year as these supplies disappear one by one, we are kept constantly reminded that no office can be too well supplied with Dixon's materials.

The Howells Drill Company, of Plymouth, Pa., has recently erected a commodious new brick building for its constantly increasing business. This building, which is 150 feet by 40 feet, is two stories in front and one story in the rear, and has four times the capacity of the present plant. It is located at the corner of Main and Academy Streets, near the Parrish Colliery, and is provided with its own electric light plant and its own telephone exchange. It also contains a 50-horsepower engine and a

40-horsepower boiler. The pattern shop and drafting room are on the second floor, and the offices, show room and stock room on the main ground floor.

The "Quick as Wink" hose coupling having been found to be a time saver in shops where compressed air is used, is now coming into general use on hose for pneumatic tools and machines. Messrs. Frick & Lindsay, of Pittsburg, Pa., who deal largely in pneumatic hose have contracted with The W. J. Clark Co. the manufacturers, for a continued supply of the Quick as Wink couplings for such purpose.

The A. Leschen & Sons Rope Company, whose main office is at 922 North First Street, St. Louis, Mo., has recently opened an office and warehouse at 92 Center Street (corner of Leonard), New York City. A very complete stock of wire rope will be kept here and the company will therefore be prepared to make more prompt shipments even than it has done in the past. This company owns and manufactures the Leschen Company's patent aerial wire rope tramway, which is extensively used in transporting ore, rock, timber, and other materials both over mountainous and over level country. One of the particular features of this tramway is the automatic loading and unloading, the tramway being operated by one man, and its cost of maintenance being very low.

The Trenton Iron Company, of Trenton, N. J., desires to inform its patrons that they have just issued a new book of 48 pages, entitled "Wire Rope and Its Application to the Transmission of Power, Etc.," which is well illustrated, and replete with valuable tables. It contains information of a general character concerning wire rope, and its special applications to the transmission of power, suspension bridges, etc.; also matter relating to wire rope fittings, sheaves, and tackle blocks. It is distinct from the previous publications of the company on the subjects of Wire Rope Tramways, Cable Hoist-Conveyors, and Wire Rope Haulage, and should not be confounded with these in any way. The book will be mailed upon application, free of charge, to engineers, contractors, and all users of wire rope.

Bethlehem Steel Company reports that a contract has been closed with General Electric Co. for six more of the weldless field-rings of "Bethlehem" Nickel-steel for the extension to the big power-plant at Niagara Falls. These rings measure 142½ inches outside diameter, and 130½ inches inside, leaving the walls 5½ inches thick. The width of face is 50½ inches and the estimated weight of each ring is about 35,000 lb. They will be worked up on a mandrel, under the hydraulic press and are said to be among the largest forgings of this sort which have yet been produced. Among other orders now in hand at the Bethlehem works may be noted the shafts and engine forgings for one of the new ferry boats which are under construction at the yards of Harlan & Hollingsworth, Wilmington, Del., for the New York ferry of the Central R. R. Co., of N. J.

The 234-page catalogue of the Chicago House Wrecking Company, West 35th and Iron Sts., Chicago, shows the enormous range over which the materials handled by this company run. It contains anything from a washboard to a house and lot, and from a screw or a horseshoe nail to a complete engine plant. This company is undoubtedly the largest concern of its kind in the world and it is prepared to purchase almost anything. Among its notable purchases in the past were the World's Fair buildings, the Trans-Mississippi Exposition, etc. In addition to the enormous quantity of second-hand machinery always on hand it is prepared to furnish almost any kind of new machinery, as it is continually buying out complete stocks of all sorts. In addition to the comprehensive catalogue noted above, it issues a monthly bulletin which will be sent to any one upon application.

The Metallic Extraction Co. appealed the decision rendered in the Circuit Court of the United States for the District of Colorado enjoining them from infringing U. S. Patent 471,264 granted to Horace F. Brown. This appeal came before the U. S. Circuit Court of Appeals, May Term, A. D. 1900, and the previous decision was very broadly affirmed. The patent relates to an improvement in stirring or rabbling mechanism for roasting furnaces, and the most important claim of H. F. Brown's patent is to the use of supplemental chambers partitioned off from the roasting hearth so that the wheels and bearings by which the rakes or rabblers are moved are protected from the heat of the roasting hearth. Brown's patent was decided by Judge Thayer to cover location of the supplemental chamber, either below the hearth as in the Ropp furnace, or at the sides as in other infringing devices, or in any location accomplishing the same result of protecting the bearing mechanism by placing it in supplemental chambers. The Brown furnace is made solely by Fraser & Chalmers, Chicago, Ill.

The Lunkenheimer Company celebrated the opening of their new branch factory recently by a reception and dance, which was attended by about one thousand people. The Lunkenheimer business was founded by Frederick Lunkenheimer in 1861, on E. 7th

St., Cincinnati, Ohio. It was started in a small way, but soon began to grow, until in 1867, larger quarters were occupied. In 1881 it again required larger quarters, and a new factory was built. The business was incorporated in March, '89, and reorganized in 1892. The officers are E. H. Lunken, President; D. T. Williams, Vice-President; C. F. Lukenheimer, Treasurer; S. L. Moyer, Secretary; Wm. Muench, Auditor. The Superintendent of the manufacturing department is Henry Ritter. For several years, the business has increased so rapidly, that the present quarters were outgrown, and as it is not possible to obtain sufficient adjoining property to take care of the growing business, the present Branch Factory was begun. It is the intention to add two more buildings of about the same capacity each, as the present one, as well as a large foundry 100 × 180 ft. in the early spring.

The B. F. Sturtevant Co. of Boston, Mass., reports its business of the past year to have been the largest in its history. In the line of standard types of blowers, exhausters and hot blast heating apparatus, its products have kept pace with the recent industrial movement. But in the installation of fans for the production of mechanical draft for steam boilers the desirability of this method in preference to the chimney has been shown by a great increase. The volume of domestic and foreign orders for forges has been noticeable while the output of the rapidly growing electrical department has been far in excess of the previous year. This electrical output has been principally in the specialties of this company, namely, electric fans of all types and small high grade generating sets. New applications of fans are constantly presenting themselves and the careful study which this company gives to the solution of such problems is one of the main factors in its growth. All departments have been taxed to the utmost and the outlook is favorable for the continuation of this condition. In order to provide facilities for conducting its rapidly increasing local business the company has just removed its Chicago office to much larger quarters at 281-289 South Clinton Street.

With the beginning of the new century, work was started in the new boiler works of The Babcock & Wilcox Company at Bayonne, N. J. The engine was started at midnight, at the dawn of the new year, in the presence of the Mayor of Bayonne and a number of the city officials and the officers and heads of departments of The Babcock & Wilcox Company. Operatives went to work at once in the drum shop, which is the first department to be put in operation; and in the presence of the guests a steam drum was completed out of the flat sheets. Those present witnessed all the operations of shearing, punching, rolling, riveting and assembling involved in its manufacture. Supper was served to the guests and toasts were drunk to the success of the new plant. The new works of the Babcock & Wilcox Company are located at Bayonne, where the company has purchased thirty acres of land, having a frontage of 650 feet on the Kill von Kull, with a depth of water 25 feet on the pier line. The plant is the largest of its kind in the world. The buildings completed have a floor area of about 160,000 square feet, to which will be added at once buildings of approximately 40,000 square feet floor area. The plant is equipped throughout with special tools; and has been designed with the greatest care to expedite the processes of manufacture by reducing to the last degree the needless handling of material and by the use of the most approved appliances. The business of The Babcock & Wilcox Co. is over thirty years established, beginning with the partnership existing between Babcock & Wilcox in the manufacture of engines in the early sixties. The first boilers were built by them in 1867. The partnership was changed in 1881 to the present corporation. The works of the company have hitherto been located on grounds leased from the Singer Manufacturing Co. in Elizabethport, N. J., but the enormous growth of the business in later years made necessary an increase in productive capacity and in 1899 the company decided to build the new works now nearing completion. The site chosen is an ideal one. So large a tract of land with so desirable a water frontage close to New York City is exceedingly difficult to obtain, and in most instances such a manufacturing site can only be obtained by filling in soft marshes fronting on the water. The site occupied by the Babcock & Wilcox Co. is remarkable in that it consists wholly of solid ground, no piling having been used for either the buildings or the heavy foundations required for the machinery installed. A spur track from the Central Railroad of New Jersey enters the property, so that the company enjoys the best of facilities for shipping both by rail and water. The famous water-tube boilers manufactured by The Babcock & Wilcox Co. have a world-wide reputation. The success of the water-tube boiler dates from the first boilers of their manufacture. In addition to the enormous business which they are doing in stationary boilers the company have in the last few years entered into the manufacture of marine water-tube boilers which are now extensively used in the United States Navy, are being introduced in the British Navy, and are very widely used in the merchant marine.

LAKE SUPERIOR IRON TRADE DURING 1900.

Output and Growth of the Industry—The Ore Reserves and the Conditions of Ownership and Transportation,

Written for MINES AND MINERALS by Dwight E. Woodbridge.

Considering the fact that the close of the century marks also the end of the first half-century of activity in the iron mining region of Lake Superior, the development has been one of the most astonishing of this wonderful age. It is a short half-century, too, for no mining of importance could be done until there was water connection between Lake Superior and the east, and this did not come until 1855. In that momentous year the first ship canal at the foot of Lake Superior was cut and the Jackson mine began small shipments of ore. For years the industry was small, it was the day of 8-ton railway cars or, still more primitive, of mule railroads, of 500-ton ships, hand drills, black powder, open pit mining and the like. It was the day of beginnings and of small things, in a word. For some years the product of the Lake Superior mines was handled over a mule tram road to Marquette. Up to ten years later or nearly to 1870 a 700-ton ship was an enormous craft and the loading of this great ship required two days and its unloading more than that. Many men of today remember sales of ore at Pittsburg at \$18, or about the price of steel billets now. Instead of the tram road there are eight great railways engaged in the ore business hauling cars loaded with 50 tons each behind locomotives of 240,000 pounds weight. Instead of the 700-ton ships, those of the beginning of the new century carry 7,000 or 8,000 tons, and instead of consuming four or five days in loading and unloading they are loaded in two hours and emptied in ten. Instead of 10 to 12 trips a year they are making 20 to 25. In connection with this, instead of old time prices ore is now bringing on Lake Erie docks little more than the actual mining cost of the early years, and in the past three years has actually sold when delivered at Cleveland at less than the mining expense of as late as 1887. Not longer ago than 1871 a drift was driven at the Cleveland mine at a cost of \$100 per foot. Now it could not cost \$15. Nitro-glycerine and power drills have been the humanizing and civilizing agencies in great measure, and civilizing these have surely been, for where would be our supremacy today but for the reduction in costs they have brought about?

From a few thousand tons a year, less than 100,000 to the time of the civil war, the production has increased till it reaches nearly 20,000,000. Another year and it will be greater still. The question is can such a draft be met, and can the lake region continue to increase its product as the indications are that it will be called upon to do? In time, of course, such vast mining activities will result in depletion of reserves, but when? Indeed no man can answer that. One mining manager knows, possibly, what his company may have, but his knowledge of the reserves of his neighbors is very limited. That there is enough for many, many years is not to be questioned. The old ranges are not so great, though the oldest of them all has steadily answered the demands and never but once made such an output as the past year. Is it possible that it has passed its zenith and is hereafter to go downward? It appears to me that the reason of the slight decrease of the Marquette's production for 1900 is to be found in local causes and that it can and will mine in an early year more ore than the 3,750,000 tons it produced in 1899. The number of operating mines has decreased materially in recent years, though it is now growing once more. In 1894 the low point was reached, with but 70 producing mines. On the Menominee range alone 10 were closed that season. In 1899 the number had risen to 94 and the past year it has again moved up a notch, with 106 active properties. The present year will probably see still more. Most of these new mines are not, however, so new as they appear. They are, in almost every case, except on the Mesaba, old and abandoned mines that, by reason of later discoveries as to their ore bodies, or in virtue of a demand for classes of ores that had been neglected, are now of value. Siliceous ores and limonites, not in the past saleable, have in some cases become so and are mined. The demand for these ores will probably increase. So also with lean bessemerers of which there are many millions of tons in reserve on old ranges, their day will come. The high grade ores that have made the region famous and have given iron masters of the northern United States advantages over their brethren of all the world, are fast disappearing. Mines once full of them are now finding nothing of the rich, low-phosphorus quality then so plenty. The Minnesota mines of Soudan, Vermillion range, now ship no bessemer ores, though once they were rich in them. The Pittsburg & Lake Angeline is low in bessemer, though it is famous as a producer of such grades. The same is true everywhere on old ranges.

The shipments of the past year were about 42% Mesaba. This is not much of an increased percentage over recent years,

but it is more than furnacemen like to use. Some say they cannot take such a proportion. The day is coming when they will have to take more, and a great deal more, and it is not distant. Furnace managers have surmounted difficulties far greater than the use of Mesaba ore in quantity, and men that have mastered the problems of producing a pig iron within the exceedingly narrow limits set by consumers, or have reduced their fuel consumption to a point approaching theoretical possibility, or have run their blast furnaces at pressure for many months continuously, can overcome any objection to the more extended use of Mesaba's fine and dusty ores when the occasion requires.

Though the railways of the Mesaba can handle more than 12,500,000 tons a year if required, the mines of that range can overload the roads without any difficulty. There never has been a time when they could not do this. It is a fact also, not alone of the Mesaba but to a considerable extent of the other ranges as well. There is capacity for the movement from the various ranges by rail to lake ports of not less than 25,000,000 tons in the season of seven or eight months, and this has not yet been seriously taxed.

A feature of the year's business has been the enormous shipment of a few individual mines. The leading seven shipped more than 750,000 tons each, the leading two more than 1,000,000 tons. In the seven is not included the Cleveland Cliffs company, for though its total shipments were more than 1,000,000 tons there was no one of its mines that reached the lower figure. The seven, then, are the following:

Fayal, in Minnesota.....	1,252,950
Mountain Iron, in Minnesota.....	1,001,824
Chapin, in Michigan.....	925,525
Biwabik, in Minnesota.....	924,868
Mahoning, in Minnesota.....	911,020
Norrie, in Michigan.....	606,766
Adams, in Minnesota.....	777,321

There are several interesting features in connection with the list above. First it may be noted that of all the mines mentioned five are in Minnesota, and that the development of the oldest of the five is but eight years of age. Then all but one are the property of steel makers and that one belongs to a transportation interest. The seven shipped more ore than all the mines of the region so lately as 1893. Up to 1892 no mine had ever produced as much ore as the smallest of them, and there was but one in the class up to 1896. These facts furnish food for thought.

The mining business of the Lake Superior country is unique in its way. There is no such development anywhere in the world, no such movement of freight waterborne. The ore shipments of Lake Superior, equated as to distances, are about one-seventh of the railway business of the United States. Then the rail business of carrying this same ore to the upper lake docks, a distance varying from 15 to 120 miles, and the connected business of carrying it from lower lake receiving docks to furnaces, another distance varying from a few miles to 125, makes up another large share of the rail traffic of the country. There is no similar freight movement in the world, that from European mines, like their output, being meagre in comparison. There is no such mining corporation in the world as the Oliver, which is mining on every one of the five Lake ranges, and the past year produced about 5,250,000 tons of ore. The next great producer is the Minnesota Iron company, that in the year produced 2,900,000 tons from its mines in the state of Minnesota alone, a state that had no mines and no facilities for their operation until 16 years ago. There are no companies in the world that approach these. Their feats of engineering skill and endeavor are superb and unequalled. There has just been installed at the Penobscot mine a pumping plant of 7,500 gallons a minute capacity, lifting against a head of 310 feet. Aside from the Chapin pumps it is the greatest plant ever put into an iron mine. One contracting firm of the Mesaba range has had under way during the year, the removal of nearly 5,000,000 cubic yards of earth and other material and has actually moved nearly half that volume in the short season. Steel shaft houses and headworks are taking the place of wood, even in the forest-covered country in which the mines are located. Steel lined and timbered shafts are beginning to go in, two of that style now being under way. Open pit mining is carried on at the depth of 150 ft. and steam shovels at that depth mine ore and handle it for belt line tracks that convey their loads to skipways, where six ton loads run up at the rate of one every minute. More than 85,000,000 gallons of water were moved from an open pit in ten days, all by a plant improvised for the purpose on almost instant notice. Ore has been delivered to railways at the rate of 10,000 tons daily for considerable consecutive periods, and the Fayal mine with three shafts and an open pit shipped in seven and a half months more than 1,250,000 tons. Three-fourths of this was mined in that length of time.

Little ore is shipped from the Lake district that does not carry at least 60% of metallic iron, by assay. Comparatively little ore is shipped to other great centers of production in the world

that goes as high, and the average of the home ores of Great Britain is not over 45%, if as good. There are in the lake district vast beds of low grade ores both bessemer and non-bessemer, that are not now valued but that will some day be utilized. All the past summer stripping was carried on at a big Mesaba mine and for much of the time ore running 55% was wasted in the dump. It took months of argument, or worse, on the part of the agents of the fee holder to convince the lessee that he must not waste that ore but must pile it where some time it may be got at. For years ore of about the same grade at other Mesaba properties was wasted with the stripping, and it was only under what may be called duress that the practice has been discontinued. The wagon and rail roads along that range are surfaced with ore better than is melted in the furnaces of many an important iron producing region. There are possibly hundreds of millions of tons of such ore to be had on the various ranges. Now the cost of transportation will not permit its use. If one of the seats of the iron production of the United States takes another move westward and reaches the western end of the lakes, this ore will be available. That such a removal may come in time no one will perhaps be willing to deny. A large western market is the one thing necessary to make such a step profitable, and with the extension of trade in the Orient there is no telling what may result.

The past year has seen one important move in the Lake region in the opening of a new ore range that may become of much importance when its area is explored and it is reached by railways. This is the Michipicoten range, at the east end of Lake Superior, 120 miles north of the Sault, in Canada. The beginning of development there was in August, 1899, now there is a road, a mine, docks, and a shipment for 1900 of 62,000 tons. Preparations are going forward actively for a shipment during the coming season of 3,000 tons daily, and there is no reason why this may not be attained. There is equipment and mining facility, and there is ore sufficient, of a quality reasonably good, though not so high as some recent reports would have us believe. There is an ore range traced already for many miles and known to contain many mineral deposits, probably of worth. There are enthusiastic and wealthy men behind the operation, with some furnace connections and with plans of the most far reaching magnitude, so vast, indeed, as to appear to the doubter almost impossible of realization.

The coming year will see another development of mining in Canada, the magnetites of the Atikokan range, west of Lake Superior and north of the Minnesota ranges. The ore is of very high bessemer grade and the distance to Lake Superior is not too great for economical handling thereto. Explorations are now under way on a large scale and by a company that will let no stone remain unturned to find what it is led to expect. There are other deposits in Canada, along the lakes, that are under exploration but none that seem so favorable, at the present writing, as these two. There is a vast field for exploration and there is no doubt that it will be diligently examined in the immediate future. So far much of the Canadian exploration has been disappointing.

It will be impossible for several weeks to give the exact figures of the ore production of 1900, for the reason that the all rail movement, which has been the largest in many years, is not yet computed. It is estimated at 600,000 tons, of which nearly all comes of the Gogebic and Menominee ranges. The water shipment is as follows, compared with the similar movement of the year preceding:

Range	1899	1900
Mesaba	6,596,042	7,763,280
Marquette	3,640,600	3,304,070
Menominee	3,150,900	3,193,022
Gogebic	2,748,816	2,752,675
Vermillion	1,765,000	1,655,799
Michipicoten	—	62,500
All rail	350,446	600,000
Total	18,251,804	19,380,946

With a water shipment much greater than the preceding year it will be seen that the excess of shipments arises from all ranges but the Marquette and Vermillion.

More than 5,500,000 tons of ore was handled during the year by the Chicago & Northwestern road, mostly to its docks at Escanaba, part to Ashland and part all rail to Chicago furnaces. This is the greatest tonnage ever made by one railway. The Duluth & Iron Range follows with an excess of 4,000,000 tons, and the Duluth, Missabe & Northern is quite close with 3,900,000 tons.

Comparisons between the profits of iron and other forms of mining have frequently been made, to the apparent detriment of the iron industry. It is true there are no such profits in the division from companies mining iron as those mining copper, for

instance, but this is easily explained. So many of the mining companies of the present day in the Lake Superior region are organized to furnish raw material to the steel works of their owners at cost, the question of profits being eliminated in all the preliminary steps of the operation from mining to the sale of the finished material, and culminating at the end in a profit on the ultimate product, that the number of dividend payers is very small. If ore should be credited by these mining companies at the price given for independent ores of the same grades there would be, for the past year at any rate, dividends to astonish the financial world. One mining company, for instance, operating on the Vermillion range, that though owned by a steel maker yet preserves its identity, has declared and paid during the year dividends of 150% on its \$1,000,000 capital. A net profit of \$2 a ton has not been uncommon for the year's operation of desirable bessemer mines, and when the product runs into the hundreds of thousands of tons this is a very pretty figure.

This point emphasizes the fact that has been brought out at various times, that most of the mining of the lake region is now being carried on by companies affiliated with consumers of ore and makers of steel. Of the mining of 1900 I think it is safe to say that not less than 70% has been by steel makers, some of whom have not a pound for outside sale, while others have a more or less important fraction of their output for the general market. The Vermillion range is completely in the hands of the steel makers, and of but two of them, the Federal and Carnegie steel companies taking its entire output of bessemer and highly desirable non-bessemer ores. The larger share of the output of the entire Gogebic range is in the hands of the Carnegie company alone, which has the past year increased its holdings there by the purchase of the Aurora mine, a producer good every year for 200,000 tons. On the same range the outside properties have been reduced by the Atlantic, bought by the American Mining company, by the Jackpot, now being reopened by the Pittsburg & Lake Angeline Iron company, a subcorporation of Jones & Laughlin, Lim., and by other properties that though not owned by steel makers are not free to sell on the market. More than 7,000,000 tons of the Mesaba range's output are by consumers, of which the Federal Steel leads. The Marquette's largest mines are independent but the Lake Superior group and the Regen Iron Company's mines are largely held by the Carnegie company. On the Menominee range the Chapin, with its 1,000,000-ton output of highly desirable ore, the Pewabic, and others are owned by steel making interests.

So there is little out of the hands of these large combinations. The bessemer ores not tied up by them are confined to a half dozen or less small properties of the Menominee, a few more of the Gogebic, and two or three companies of the Mesaba. But, as the steel making end of the trade is well aware, there is a dwindling also in the number of independent ore consumers, and with the gradual increase of furnace facilities by the larger concerns there will be less and less market for bessemer pig or demand for independent ore.

The whole tendency of the iron trade, mining, transportation and reduction, is toward concentration. This is not seen merely in the mining region but in the business of lake transport. There was a movement by lake of more than 18,700,000 tons of ore the past year. Of this the Rockefeller shipping interest is able to move not less than 4,000,000 tons from the head of Lake Superior to foot of Lake Erie. The Federal Steel company has ships for carrying 2,000,000 tons and the Carnegie Steel company about as much. The American Steel and Wire company can move more than 1,500,000 tons in the season, the National Steel and other consuming interests about 2,000,000 tons more. There are, then, ships on the lakes at present owned by steel making and ore mining companies, to carry nearly two-thirds of all ore moved. Just at present none of these concerns are building ships, for the reason that they see, what seems to have been denied to the sight of smaller lake shipping interests, that during 1901 ore rates on the lakes are likely to be lower than these companies will care to carry it for. That they will continue their policy of building ships to take their own freight as soon as they see any profit there can be no doubt. In the meantime they are content to let independent ship owners build boats for the fun of the thing.

There are now in the upper lake region nine railroads engaged in the business of transporting ore to docks. Of these, four were built and are maintained exclusively for the ore business. These are the Duluth & Iron Range, the Duluth, Missabe & Northern, the Ishpeming & Lake Superior, and the Algoma Central. The first is the property of the Federal Steel company, the second of the Rockefeller mineral interest, and the third of two of the large mining concerns of the Marquette district, the fourth of the Clergue syndicate. The railway investment, including docks and rolling stock, for the delivery of ore to the upper lake ports is in the neighborhood of \$80,000,000.

THE TONG COLLIERY,

Kaiping, North China—A Description of the Coal Seams, Methods of Working, and the Machinery Used.

By Mr. Thomas Webster.*

The mineral area is known as the Kaiping Coalfield, and is situated eighty miles north of Tien-tsin, in the province of Pei-chih-li. His excellency Chang Yen Mao, better known as Chang Yi, is Director of Mines in the province.

The extent of the coalfield has not been proved, because of the great depth of alluvial sand on the surface; at some places this stratum has been bored to a depth of 260 feet.

The coal deposits are of the Carboniferous age, at the base of which there is a great mass of dolomite and limestone projecting along the western outcrop hundreds of feet above the surface of the plain; underneath the limestone the old red sandstone is easily recognized in some places, the strata having been subjected to a considerable amount of contortion and displacement.

The mineral outcrop has been proved on the west of the basin for a distance of 25 miles, by mining operations at Tong Colliery, and borings to a depth of 100 fathoms distributed along the outcrop at Pam-peit-tien, Mao-chia-cau, Chao-ko-Chuang, and Woh-shui-chuang, with good results. The natives formerly worked the coal near the surface, where the alluvial stratum was not thick, the coal being raised from small shafts by jackrolls. The outcrop has been proved on the north-east side of the basin by the mining operations of the Chinese Engineering and Mining Company at Linsi Colliery, under the direction of Kwong Yung Kwang, Esq.

TONG COLLIERY.

Colliery operations were commenced on a large scale at Tong Colliery, Tongshan, in 1879, by the late Mr. Tong-king-sin, an enterprising merchant from Shanghai. The progress of the work was much impeded by the superstition of the natives, and on this account he had many expensive battles to fight in Peking. At the end of 1882 the output raised was above 20,000 tons of coal.

The colliery is situated 80 miles north of Tien-tsin and convenient to Tongshan Station, on the Imperial Chinese Railway. A railway was constructed from Tongshan to a canal basin at Su-ko-chuang, a distance of five miles, the coal being transported from there by canal to Tongku and Tien-tsin. The railway to Tien-tsin was opened for traffic in 1886.

There are three shafts sunk from the surface—No. 1 shaft, 14 feet diameter, 548 feet deep, walled with limestone throughout to No. 3 level; No. 2 shaft, 14 feet diameter, 270 feet deep, to No. 2 level.

No. 3 shaft, 16 feet diameter, in process of sinking, is 1,230 feet deep, and will reach No. 7 level at a depth of 1,300 feet; the shaft is walled throughout with limestone blocks, which are accurately fitted together on the surface before being sent down. The method adopted is to sink the shaft 120 feet, or to a suitable bed, on which the walling cribs are placed; sinking is abandoned when building operations commence. A cradle, suspended in the shaft by ropes from a crab engine on the surface, is lowered to the walling crib, and gradually raised as the building advances. The crab engine is comprised of double 12-inch cylinders by 28-inch stroke, two drums 5 feet diameter, working load 30 tons.

The seams worked are of the Lower Carboniferous series, and vary in thickness from 2 feet to 150 feet; in some places two or three seams run together for about 200 yards, making a coal of 150 feet, then spread out again.

The seams are numbered 1 to 13 from south to north, with inclinations varying from 45° to 90°. The workable seams are Nos. 2, 3, 5, 8, 9, 10, 11, 12, and 13. Nos. 5 and 9 are the most valuable. Fig. 1 shows a section of the strata passed through at each of the shafts. The intervening strata comprise sandstones, argillaceous and calciferous rocks.

At the shafts and to the east the strata dip south at an angle of 45°; towards the west the angle of dip increases till, 3,000 feet from the shafts, the seams are vertical; at this point the direction of dip changes to N. 40° W. At 10,000 feet from the shafts the dip decreases to 55°; the area is subject to the inconvenience of little faults and wants.

METHOD OF WORKING.

There are seven levels, No. 1 to No. 7. No. 1 and No. 2 levels are practically exhausted; the vertical distances apart No. 1 to No. 2 level, 100 feet; No. 2 to No. 3, 250 feet; and each of the others 185 feet. The haulage road in each level is generally formed in No. 6 seam, cross-measure drifts are driven from the haulage road north and south at intervals of 1,000 feet. Nos. 1, 2, 3, and 4 east levels are exhausted, and extend 3,000 feet to a dislocation which

is in proximity to a huge mass of running sand; Nos. 5, 6, and 7 levels east are still in operation. Nos. 2, 3, 4, and 5 levels west extend 10,000 feet from the shafts; the seams are tapped by the cross-measure drifts. No. 5 seam only is wrought between Nos. 3 and 4 levels, the other seams are reserved as a barrier to prevent No. 3 level water as much as possible from going to the dip; the cross-measure drifts and levels in each seam, No. 4 level, are driven to complete the ventilation of the lower levels.

The seams are worked on the stoop and room principle; the levels are driven ahead in each seam from each side of the cross-measure drifts; inclines are driven 500 feet apart to the next level above. When the area has been formed into stoops, these are taken out and the waste packed from the level above, the material being got from the surface for this purpose.

Where the seams are thick, stoops are formed in the floor and in the roof as if two separate seams, the crossheads being connected by crosscuts driven through the seam; practically all the stoops can be got if the packing of the waste is properly manipulated.

Hitherto the seams were worked on the Belgian principle, the upsets were driven from one level half-way to the next, crossheads driven between; each alternate upset formed a jinney, or self-acting incline, with small wooden carriages, on which were placed baskets containing coal, carried from the face to be lowered to the tub on the level. From the level above, dips were sunk to meet the upsets, and crossheads driven between; each alternate dip was fitted with a jackroll, and wooden carriages containing the baskets were wound up by four coolies, no tubs being taken into the face.

It was a usual occurrence to meet the coolies on their way from the face to the incline, swinging a short bamboo on their shoulder, having a basket of coal suspended from each end by a piece of rope. This method is gradually undergoing a change, tubs being got into the face, the change proving a boon to all concerned. The old method of using baskets was given up

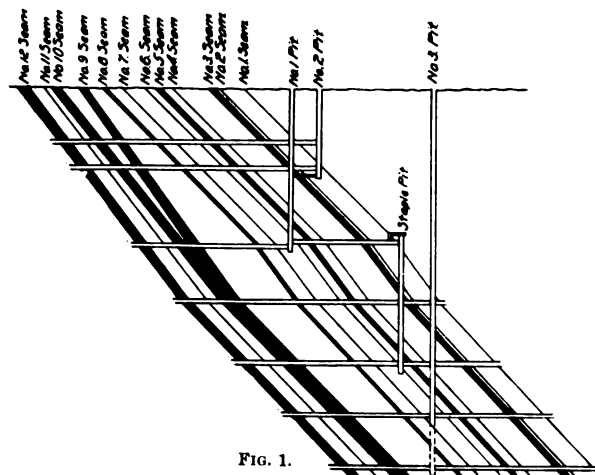


FIG. 1.

with great reluctance; even when the tub was close to the face they persisted in filling the coal into baskets, which in turn were emptied into the tubs. The coolies are very unskilful in cutting the coal, which is got by the pick and wedge. No blasting is allowed, about 20 per cent. of lump coal being produced.

VENTILATION.

The obnoxious gases met with are black damp in each of the levels, and an occasional accumulation of firedamp in No. 7 level. The whole workings are ventilated by three fans of the Guibal type; No. 1 and No. 3 shafts act as downcasts, No. 1 fan exhausts at the top of No. 2 shaft, is 30 feet diameter by 10 feet wide, encased in brickwork, driven at 50 revolutions per minute by a single direct-acting non-condensing engine, cylinder 24 inches diameter by 24-inch stroke, with duplicate in reserve having cylinder 20 inches in diameter; quantity of air, 60,000 cubic feet. There are two fan-drafts in No. 5 seam, on which Nos. 2 and 3 fans are placed respectively.

No. 2 fan is 30 feet in diameter by 10 feet wide, driven by a single direct-acting non-condensing engine, cylinder 18 inches diameter by 24-inch stroke, at 50 revolutions per minute, with a duplicate of the same dimensions in reserve, exhausting 60,000 cubic feet of air per minute. No. 3 fan exhausts from the drift, known as the steam-pipe rise, is 16 feet diameter by 7 feet wide, driven by a single direct-acting non-condensing engine, cylinder 10 inches diameter by 28-inch stroke, at 60 revolutions per minute; quantity of air, 22,000 cubic feet.

* Proceedings South Wales Institute of Mining Engineers.

HAULAGE.

In No. 3 level west there is a main and tail-rope haulage 6,000 feet in length, driven by a double horizontal engine, 10-inch cylinder, geared 1 to 4. Fifty tubs on each train, speed 12 miles per hour (average). There is an automatic detaching piece at each end of the train to free it from the rope at the journey's end. The haulage inbye and in the other levels is performed by mules, each drawing six tubs. Mule-drivers carry safety lamps to preserve their lights in the high velocity of air currents. Timber is expensive and difficult to get. The haulage roads are arched from end to end with 10-inch brickwork 8 feet 6 inches wide by 7 feet high. On the dip side-drain tiles are laid to carry off the water. There is an ingoing and outgoing line of 25-lb. rails in each road.

The coal in Nos. 4, 5, 6, and 7 levels at present is raised in three inclines driven in No. 5 seam, and a staple shaft from No. 5 to No. 3 level by underground winding engines. No. 7 level coal is raised to No. 6 level by a double horizontal-geared engine, cylinders 12 inches diameter by 28-inch stroke, drum 4 feet 6 inches diameter, situated in No. 5 level. No. 6 level coal is raised to No. 3 level by a double horizontal engine, cylinders 18 inches diameter by 30-inch stroke, drum 6 feet diameter.

Nos. 4 and 5 level coal is raised to No. 3 level by double horizontal engines, cylinders 12 inches diameter by 28-inch stroke, drum 4 feet diameter; each incline has a double line of rails, with double carriage on each, single deck. All inclines built with brickwork 9 feet 6 inches high by 9 feet wide. Staple shaft winding engine, double horizontal cylinder 24-inch stroke 14 inches diameter, drum 8 feet diameter, geared 1 to 3. The completion of No. 3 shaft arrangements will do away with the incline engines.

WINDING.

An output of 1,800 tons is raised from No. 3 level by No. 1 shaft winding engine, double horizontal cylinder 28 inches diameter by 4-feet 6-inch stroke, fitted with Cornish valves, drum 19 feet diameter with a brake ring on each side acted on by under-ropes and steam-power brake; cages double decked, two tubs tandem on each deck; four steel-wire rope guides to each cage, the inner guides are fixed 1 foot 9 inches apart, each cage fitted with a safety detaching hook.

The heapstead is comprised of stone pillars with a backstay of brick built up to the top-deck landing; these pillars receive a pulley frame of steel girders about 40 feet high.

No. 2 Shaft.—There is an output of about 40 tons of coal per day. This shaft is used to lower the material from the surface to pack the waste. Double horizontal winding engine, cylinders 10 inches diameter by 16-inch stroke, drum 6 feet diameter, geared 1 to 6.

No. 3 Shaft.—Sinking engine, double horizontal cylinders 22 inches diameter by 4-feet stroke, drum 10 feet diameter; the arrangements are being fitted up for an output of 2,000 tons per day. The manufacture of the winding engine, heapstead, and screening plant has been entrusted to Messrs. Guttehoffnuncshutte, of Berlin, and they are being erected by natives under the supervision of the makers' representatives. The erection of the winding engine has been completed. Double horizontal cylinders 33 inches diameter by 60-inch stroke, fitted with Cornish valves and tachometer; an automatic mechanical lubricator, worked by a connection from the lower end of the valve link-motion, is attached to the cylinder. The drum, 23 feet diameter by 8 feet wide, weighing 60 tons, is built up from four cast-iron center-pieces keyed to a 15-inch hollow shaft; four cast-iron bosses, prepared to receive four sets of arms of channel steel, are bolted in halves to the center-pieces. Twelve arms of steel girders are bolted to each boss; the arms of each pair of bosses are secured by struts and ties.

A brake ring of steel is fitted on each side of the drum, and is acted on by steam-power brake, which acts automatically in the case of an overwind. Cages, double-decked, built of steel to carry three tubs tandem on each deck, both decks change simultaneously; each cage is attached to three guide ropes, the inner guides to be 15 inches apart. There are also two skitting ropes between the cages to slide the cages past each other at the meetings in the shaft. The pulley frame is of steel lattice-work 75 feet high, with overhead traveling-crane on top for changing pulley-wheels.

PUMPING.

The influx of water into the workings has gradually increased with the advance of the levels; total growth raised to the surface is 1,700 gallons per minute. No. 7 level gives off 200 gallons per minute, which is raised to No. 5 level by a direct-acting horizontal condensing double pump of the rotary type. Cylinders 14 inches diameter, 24-inch stroke, double-acting rams 7 inches diameter. No. 6 level, 200 gallons per minute, raised to No. 5 level by a double rotary pump, direct-acting horizontal, cylinders 14 inches diameter by 28-inch stroke, double-acting rams 7 inches diameter.

No. 5 level growth 300 gallons, and 400 from the lower levels, amounts to 700 gallons per minute, raised to No. 3 level by a direct-acting horizontal double rotary pump, cylinders 24 inches diameter by 4-feet stroke, 8-inch double-acting rams. There is practically no water from No. 4 level.

Growth from No. 3 level 1,000 gallons, and 700 gallons from No. 5 level; total, 1,700 gallons raised to the surface. This is done in two lifts, each consisting of a surface pump and two underground steam pumps. No. 1 shaft: Surface pump, compound horizontal direct-acting condensing engine, with differential valve gear. Cylinders: H. P. 30 inches, and L. P. 50 inches diameter, 6-feet stroke, attached to two bell-cranks working two 20-inch buckets, lifting 800 gallons to No. 2 level. Spear-rods from the surface to No. 2 level are of 5-inch wrought-iron with screwed joints; the lower rods in the rising main are of wood. Second pump: Compound direct-acting differential by Hathorn, Davey & Co. Cylinders: H. P. 18 inches, L. P. 30 inches, stroke 4 feet, 11-inch double-acting ram, raising 500 gallons to No. 2 level. Third pump: Double rotary direct-acting condensing, cylinders 12 inches diameter by 28-inch stroke, double-acting rams 7 inches diameter, raising 400 gallons per minute to No. 2 level.

Top Lift.—Surface pump: Horizontal direct-acting condensing, with differential valve gear. Cylinders: H. P. 30 inches, L. P. 50 inches, 6-feet stroke, attached to two bell-cranks, working double 20-inch plungers in No. 2 shaft, spear-rods of wrought-iron 6 inches diameter with flanged couplings, raising 800 gallons to the surface. Second pump at No. 2 level: Compound direct-acting differential, by Hathorn, Davey & Co. H. P. cylinder 18 inches, L. P. 30 inches diameter, stroke 4 feet, 11-inch double-acting ram, raising 500 gallons to the surface. Third pump by Deans & Co.: Vertical direct-acting, cylinder 26 inches diameter, 3-feet stroke, 11-inch double-acting ram, raising 400 gallons to the surface.

An hydraulic pumping installation to raise 1,000 gallons per minute from a depth of 1,300 feet in two lifts of 600 and 700 feet, is being constructed by Messrs. Gibb & Hogg, of Airdrie; when this has been completed it will do away with most of the underground steam pumps. Each lift will comprise two Moore pumps, working side by side, 16-inch double-acting rams, 7-inch power rams, 54-inch stroke. Each lift will have two sets of 5-inch power pipes leading from two separate power engines on the surface. The power rams on the surface 10½ inches diameter, each worked by a horizontal compound condensing engine. Cylinders: H. P. 20 inches, L. P. 38 inches, stroke 60 inches, geared 6 to 1.

STEAM BOILERS.

At No. 1 Shaft there are ten Lancashire boilers 7 feet diameter by 30 feet in length, and four Cornish boilers 5 feet 6 inches diameter by 17 feet long, all under cover. Steam pressure 70 lbs. per square inch. Chimney 100 feet high, 7 feet square inside at the top, and lined to a height of 30 feet from the base.

At No. 3 Shaft there are eight Lancashire boilers 7 feet 6 inches diameter, 30 feet long, under cover; steam pressure 90 lbs. per square inch. All steel made at the works. Chimney 150 feet high, 8 feet internal diameter at the top; an inner lining of fire-brick is built up to a height of 50 feet from the base. The flues of each boiler do not unite before entering the main flue to the chimney. Each boiler has two dampers, one on each side flue.

SCREENING PLANT.

At No. 1 and No. 2 Shafts the tubs are discharged by an automatic tippler onto a screen of the ordinary cast-iron bar type. The small coal is eliminated, the lump coal sliding on to a mechanical arrangement of trap-doors, to be hand-picked and dropped into trucks underneath.

No. 3 Shaft.—There are two sets of shaking screens and picking bands. The coal is discharged from the tubs by rotary tipplers onto the jigger, which is inclined at an angle of 18 degrees. The small coal is eliminated, and the lump coal passes on to the picking bands 60 feet and 75 feet long, 4 feet 6 inches wide. Each plate of the band is 14 inches broad and curved on the outer edge, mounted on a roller frame, the whole being made to travel. The lump coal passes from the picking band to a lowering band at right angles, and is gently deposited in the wagon. The outer end of the lowering band is balanced by a weight, and can be moved up or down to minimize the breakage of the coal.

COKE OVENS

are of a very primitive type. The method adopted is that of coking in piles; the earth is excavated to a depth of 3 feet 6 inches and lined with bricks, forming an inverted cone 12 feet 6 inches diameter at the surface and 7 feet 6 inches at the base; a wall with nine air-holes is built on top to a height of 2½ feet above the level. The coal is hand-washed in baskets to remove any loose pyrites or sulphur; with the larger coal a chimney is formed in the center, and flues diverging from the chimney to the air-holes in the brick wall, small coal is filled in all around. Burning coal is

thrown down the chimney thus formed, and the whole is covered up with small coal. There are over 100 of these ovens at work. No. 5 and No. 9 seam are found to be most valuable for coking purposes. The average yield obtained is about 74 per cent. of coke plus 6 per cent. of ash.

BRICKWORK.

There is an extensive brickworks in connection with the colliery, turning out 6,000,000 bricks per annum. The clay is got on the surface, ground in pan mills, and mixed by hand for the molders; each molder without a carrier turns out 600 bricks per day. There are seventeen kilns at work, each containing 25,000 bricks; they are 19 feet 2 inches square, 20 feet high to the crown of the arch, built of 14-inch brickwork, which is supported all round by a wall of rubble masonry 4 feet thick, 10 feet high. The fireplace is sunk beneath the floor level, and is 19 feet 2 inches by 4 feet 6 inches. Each kiln takes three days to heat up, four days burning, and five to twelve days to cool, according to the temperature of the atmosphere. Fuel consumed, 17 cwt. of dress coal per 1,000.

WORKSHOPS

comprise fitting, blacksmith, carpenter, boiler-making and molding shops. The fitting-shop is equipped with excellent lathes, drilling, planing, and screw-cutting machines driven by a double 12-inch horizontal engine. There is a steam-hammer at work in the smithy. In the molding shop there are two swing cranes of 22 feet radius, and two large cast-iron cupolæ are quite convenient to it.

The miners belong to the lowest class of society, but although they are ignorant they are of a very kind disposition. They possess many remarkable traits of character; stealing is considered by them a virtue, and although they are searched by a special staff of policemen when they come out of the pit, yet they frequently manage to take away some things such as bolts, nuts, fishplates, nails, and even brattice-cloth, which they tear from the air-stoppages; in case they are caught they are not only fined for the lost article, but receive a punishment of 100 blows on their backs.

The Chinese miners have not yet appreciated the motto of their foreign brothers—that cleanliness is next to godliness; their annual ablution is performed for the New Year occasion, when they dress up in their finest clothes to receive the New Year greeting of their friends. It would be difficult at first sight to determine whether they are Mongolians or Africans. The men are very fond of sleeping when they ought to be at work. They are very superstitious, and believe in evil spirits and bad omens.

Cyaniding in Montana.

Written for MINES AND MINERALS, by Matt. W. Alderson.

One of the first successful cyanide plants in the United States was the Revenue Mill in Montana. The ore here proved admirably adapted to the process, containing but a small quantity of the base elements which cause an undue consumption of cyanide, and after quite an extended series of experiments to determine the most practicable and economical method of handling the ore, it was found that a very good extraction could be obtained by crushing to 20 mesh. This made an ideal ore for percolation and a high degree of success followed. This success led to a number of plants being erected elsewhere in the same county, but unlooked for difficulties made these efforts all prove failures, at least for some years to come. The process thus received a set back from which it took years to recover. Today, while the Revenue Mill is one of two mills in its neighborhood treating ores by percolation, there are a number of plants in the county treating tailings and ore by agitation, and throughout the state the process has made most creditable progress, the product for 1898 having been nearly double what it was for the year previous, and for 1899 nearly twice what it was in 1898. It is not to be expected that the record will continue to increase in this ratio but there will be a very marked increase this year over last and every indication is that there will be a strong, steady growth for some time to come.

The locality in the state containing the most ideal ores for the process is in Fergus County. These ores are in an isolated range of mountains to the east of the main range, which crosses the state in a northerly and southerly direction. They are in line and are largely of a porphyritic character, containing on an average less than 20 per cent. of silica. Cyanide solution penetrates the gangue easily and an extraction of 90% is obtained on ores crushed to pass a quarter inch round hole. In no other portion of the state has ore been found in quantity which could be treated so nicely, most ores requiring much finer crushing before they will surrender a fair amount of their precious contents. There are several successful mills in this section, the largest of which is the one at Gilt Edge, with capacity of 140 tons of ore per day. The average value of the ore treated at this plant is \$7.00. The gen-

eral run of the porphyry or porphyritic quartz is lower in value than this, running perhaps about \$3.00, but occasional bodies of richer ore bring up the average. The section is one of bright promise. The ores are not amenable to amalgamation and the high grade ores cannot be shipped to smelter, the cost for transportation, freight and treatment being about \$30.00 per ton. They cyanide well and there are large bodies available.

The largest tailings plant in the state is at Marysville, near Helena, the state capital. These tailings are not of high grade, but they are handled on a large scale, four hundred tons a day, at an expense of but little over \$1.00 per ton. As the extraction is about \$2.80, the enterprise pays handsomely. The finest, largest bodies of free milling ore in the state are in the near vicinity of Helena. They will yield by amalgamation 90 per cent. of their values, and as the tailings are quite amenable to cyanide treatment, the combination of amalgamation with cyanidation makes an ideal process, by which a very high percentage of the values is secured. Further to the south of Helena, in Jefferson County, particularly, are some very base, pyritic ores, with which practically no success has been made except by smelting. Further to the south, again, are ores which yield by amalgamation in the neighborhood of 50%, and the tailings range high, from \$4.00 to \$20.00 per ton. The ores when crushed make a compact, pasty slime. It has been with this class of material that the writer has had most of his experience the past five years. All attempts to handle the material by percolation proved failures the slimes not being permeable by the solution and retaining the gold to a considerable extent, even after it was dissolved. These slimy ores and tailings are now handled to perfection by agitation and decantation. The finely crushed ore has such values as can be taken from it by amalgamation and concentration. The pulp then flows to vats 16 ft. in diameter by 8 ft. in depth, where it is allowed to stand. After settling, the clear water is decanted, cyanide solution is run in and the mass is agitated with an agitator having blades similar to the propelling screw of a tug boat. The solution after agitation is decanted and passed through the regulation zinc box. Two or more decantations are made, according to the value of the material undergoing treatment. The strength of solution used is one pound of cyanide per ton of fluid during the first agitation. In this way the ore is handled expeditiously, economically and satisfactorily in every way.

As great a variety of material is successfully handled in Montana by her cyaniders as in any other portion of the universe. In size of plants for the direct treatment of ores, however, we are far behind some other sections. This is because the impression has seemed to prevail that we have no large gold mines, such as have brought Cripple Creek, Republic and Sumpter into prominence the past few years. Most mining men of means have devoted their attention to copper, till we lead the world with the production of one camp of a few miles square. But, more attention is being paid to gold properties today than for many years past. New properties are being opened and developed and properties idle for many long years are being re-opened. The future of the state as a gold producer was never more promising. She has within her limits some zones of gold-bearing granite and lime of enormous extent, where very rich float is frequently found. In some one or more of these zones we may look for gold mines the richness and extent of which will yet co-rival those of other sections. And in the handling of the ores, cyaniding will ever fill a most important place.

The indisposition of man in his migrations to select a colder country than that to which he has been accustomed is distinctly perceptible in the history of our immigration. In all the years in which detailed records of the country or origin of the millions of immigrants who have come into the United States have been carefully kept, the tropics have seldom sent an average of more than 1% of the people seeking permanent homes in the United States. This fact is especially emphasized, however, by the record of the year just ended, since it offers the first opportunity to observe whether or not the citizens of the islands now controlled by the United States indicate a disposition to transfer their residence to this country. The fact that during that year the immigration from Oceania, India, Arabia, Africa, South America, Central America and the West Indies—combined—the entire tropical territory of the world—amounts to less than 4,000 people, or less than 1% of the total immigration indicates the unwillingness of the average citizen of tropical lands to transfer his residence to even so mild a climate as that which the southern part of the United States offers. The further fact that during the year 1900 the total number of immigrants coming from the Hawaiian and Philippine Islands into the United States was less than 250 indicates still further the unpopularity with natives of the tropics of a climate such as our own, even when joined with the material prosperity such as exists in no other part of the world.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainly a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it appears like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 606 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Metamorphic Rocks.

By metamorphism is meant the process by which rocks are changed or altered; thus limestone is changed into crystalline marble, shale into slate, sandstone into quartzite, coal into anthracite or graphite. The process is usually that of heat combined with chemical action, and is one involving increase in crystallization and hardness, and the other characteristics, which we observe as making the difference between an unaltered mud shale and a crystalline schist. The appearance of the one is dull and earthy, of the other, bright, sparkling, crystalline. In some cases too, it is as the difference between a clay vessel before and after its transformation into a white porcelain cup; certain clays in nature, do, sometimes, pass into a porcelain like jasper, or into a white opaline substance called porcellanite by heat action of intrusive lavas, as for instance in a locality under the andesite flow of Buffalo peaks, Colorado.

Atmospheric Metamorphism.—The effect of the atmosphere on rocks by water, oxygen, carbonic acid, is also a species of metamorphism, sometimes changing entirely the natural appearance and character of a rock, producing disintegration, loss of ingredients, decomposition, and shrinkage of bulk. A crystal may be transformed into another form, or a great outcrop of brassy, yellow pyrites may be oxidized into a rusty "float" composed of that secondary form of iron known as limonite. Sulphide of lead, i. e. galena, crystals that have lain for years on a mine dump, have by atmospheric action been changed into lead sulphate and carbonates of lead. It is not uncommon in mines to see new forms of metals and minerals encrusting or growing on old and different forms, resulting from the long continued damp of the mine. We have seen in the wet depths of a mine successive deposits of oxide of copper and iron being deposited quite thickly from drippings through the copper and iron pyrites bodies above in the vein. The same changes by atmosphere go on in a still more marked manner in rocks. In the field it is rarely possible to get a typical fresh specimen of what a rock really is until we have cut through several inches of oxidized crust quite different in appearance and character from the unaltered rock below surface influences. The rocks around mining centers are proverbially altered, decomposed, and oxidized by surface action, mineral solutions etc., and it is not till we get far away from the mineralized zone that we can determine the true original character of the rock. Specimens of rock taken out of mineral veins are nearly always hard to determine.

Different Phases of Metamorphism.—There are three phases of metamorphism: Rocks are changed by contact metamorphism, by regional metamorphism, and by atmospheric weathering.

By contact metamorphism is meant the effects produced by contact of once molten hot bodies of lava, such as dikes and intrusive sheets and overflows on underlying or overlying beds, usually of sedimentary origin. These changes are produced by heat accompanied by vapors and hot solutions, e. g. a bed of coal may be altered into a sort of coke, or into anthracite, or into graphite by the intrusion of an igneous dike. A bed of chalk has been found changed into crystalline white marble by the same means. This is local as contrasted with regional metamorphism.

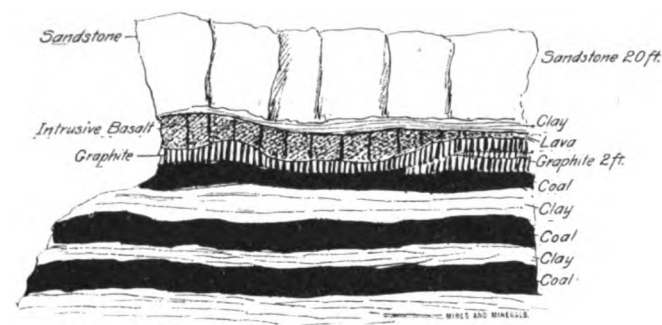
By regional is meant the series of changes produced in rocks over wide areas and regions, by deep burial, by mountain making upheavals, by long continued buried heat and pressure. For instance, on a large scale, we may consider the great granitic mountain regions as examples of regional metamorphism. Again, we have local regions in greater regions that show strong regional metamorphism. Throughout the region around Crested Butte and the Elk Range, Colorado, there appears a regional metamor-

phism over large areas. Cretaceous shales are changed to slates, limestone to marble, coal to semi-anthracite and anthracite, or even graphite. Outside of this large area the rocks may be comparatively unchanged.

Again, whilst the sedimentary rocks of the foothills on the borders of the ranges of Colorado are for the most part unaltered, the same rocks in the heart of the range over vast areas are generally changed by a regional metamorphism.

Plutonic rocks like granite, for instance, are more favorable to contact metamorphism, and produce often more marked and widespread and deeper results than volcanic lavas like basalts, because the former, cooling slowly at great depths, retain for a long time their high temperature next their walls. On the other hand a thin surface lava flow may radiate and give off its heat so rapidly into space that no heat effects of importance are produced in the adjacent or underlying rocks. We have often been surprised to find how very little heat effects were shown by a dike of basalt, for example, coming up through Cretaceous shales. The shales at contact would often be only hardened for a few inches. In other cases we may find the reverse and quite a narrow dike may produce great alternative effects on the adjacent strata and for a wide distance on either side of it. "Magmas," Kemp observes, "rich in mineralizers are more favorable to metamorphic action than those poor in them, due to the influence exerted by escaping vapors." This perhaps accounts for the great effects often observed in veins, mines and mineralized regions by igneous dikes carrying mineral solutions; the walls adjacent to such dikes are commonly much kaolinized and decomposed, or may be, on the contrary, hardened and silicified. Both phenomena are observed in different mines in Cripple Creek, both penetrated by the same phonolitic character of dike. In one case the dike is quite decomposed and falls to pieces like clay on exposure, in another mine, the same character of dike is altered into a hard jasper and other silicious forms, the results in both cases due to mineralizing solutions ascending with, or at contact of the dike, such as siliceous and fluorine vapors.

Acidic rocks like granite, trachyte, rhyolite, etc. are better metamorphosing agents than basic ones, because abundant vapors accompany and facilitate fusion of rocks high in silica, whereas basic rocks, like basalt, are the result more largely of a drier fusion. Hence it is that such powerful effects are often found



PART OF COAL SEAM CHANGED TO GRAPHITE BY INTRUSIVE SHEET OF BASALT

around bosses of eruptive granite, and often such slight action in vicinity of basalt flows or dikes. Sandstones and conglomerate walls are not easily affected, but clayey or calcareous beds are favorable to recrystallization, because they contain alumina, iron, lime, magnesia and alkalis that combine with silica under metamorphism to yield many contact minerals. An impure limestone yields the most varied results. Sometimes there can be no sign of metamorphic action from a lava intrusion as for instance, in the Moquito Range when sheets of green igneous porphyrite are included amongst hard crystalline vitreous quartzites; the quartzites, having already received their metamorphism long before the intrusion of the porphyrite, can show no further sign of metamorphic action.

Rocks Produced by Contact Metamorphism.—The igneous rock itself as well as the walls may be influenced by the intrusion. The igneous rock suffers a rapid loss of heat in its marginal portions as compared with its interior, and in consequence assumes sometimes a porphyritic, spotted, felsitic, or even at the line of contact, a glassy texture, although it may be granitoid within. Hence it is that we may observe a fine grained, dense or glassy structure just at the contact of a dike with a sedimentary or other rock, whilst the heart of the dike may be coarsely crystalline. This perhaps is caused by sudden chill of the dike in contact with the colder wall rock. Again in the Gunnison region, we have often observed a spotted character produced at contact of the igneous granite with the schists, resulting from distinct or porphyritic crystals of feldspar being

developed. Again at the contact of igneous rock with sediments, a sort of breccia or mixed zone of intrusive lava and fragments of wall rock occur. Shales and clays may be baked to a kind of flinty jasper or hornstone at the contact, with development of various silicates, such as mica, garnet, tourmaline, hornblende, etc., and the hornblende may turn into a mica or hornblende schist. At the top of Mount Lincoln, Colorado, we have seen original clays or shales so altered and standing on edge close to the great porphyry dike forming the top of the mountain, that to all intents they had the appearance of regular Archaean mica schists. On retreating from the zone of greatest heat the distinct crystals may gradually shade into mere blotches and finally die out in the unaltered rock.

Pure limestones may crystallize into pure marbles, but argillaceous or siliceous limestones become charged with various silicates, such as black mica, garnet, hornblende, pyroxene, etc.

Intrusions of igneous rock into coal seams may sometimes burn out and destroy the coal, the heat of the burning coal sometimes reacts by calcining the intrusive lava, or it may, if in close proximity, coke the coal for a space, or reduce it to anthracite or graphite. Much depends upon the distance of the lava from the coal, or on the qualities or kind of the lava itself as a heat bearer and metamorphic agent. In the southern part of Colorado where basaltic eruptions prevail, coal that is lignitic in the northern part, by volcanic emanations has been changed to a bituminous and coking coal, whilst across the range where igneous and metamorphic action is greater still and where porphyry laccolites and intrusive sheets abound, bituminous coal is locally changed to anthracite.

Even limonite iron may be altered to magnetite. Igneous rocks may be intruded into one another and show effects such as are seen in the great pegmatitic veins and dikes around granites, produced by escaping heated vapor and solutions. Some intrusions have emitted copious emanations of hydrofluoric and boracic acids, with superheated steam, attacking the whole rocks and when formed of silicates, making them porous and cellular, destroying feldspars and causing crystallization of quartz, topaz, fluorite micas, apatite and even tin. These mineralizers have been of great importance in the formation of ore deposits. At Cripple Creek we see abundant evidence of the emanation of hydrofluoric vapors in the deep purple fluorite staining of the rocks alongside the dikes. Such purple fluorite stains are generally considered there as a good sign. Both the phonolite dike and the wall rock breccia are often thus stained. Moreover the rocks adjacent to the dikes show the powerful action of these vapors by the decomposition of the rock into clay or kaolin, or an incoherent sand or gravel stone, or by silicification of the rock throughout its cracks and interstices, and lastly by the deposition of the precious metals, gold-bearing pyrites and tellurides. The most striking example of this is in the Independence mine where the coarse granite adjacent to a dike of phonolite has had its dark silicates, mica and hornblende, dissolved out and replaced by fluor spar carrying rich telluride ores.

Ottumwa Hoisting Engine.

The hoisting engine illustrated above is manufactured by the Ottumwa Iron Works, Ottumwa, Iowa. This engine is made from new patterns and every detail in the design and construction has received most careful attention from modern designers and expert mechanics.

The frame of the bed of this engine gives what is so much desired by mechanics, "the straight line strain," which prevents any vertical vibration of the bed on its foundation when running.

The valves used on this hoist are what is known as the four-ported balanced slide valve. Each inlet and exhaust port has a supplementary port which doubles the admission and exit of steam as the valve travels. When the valve moves far enough to admit steam into the cylinder through the valve ports the steam is also admitted on top of valve through a cavity, and passing down through supplementary ports, gives a double volume of steam to a given travel of valve. That is, when the valve has traveled $\frac{1}{2}$ ", there will be two port openings, each $\frac{1}{2}$ " wide. This movement insures not only a perfectly balanced valve, and therefore an easy reverse movement, but a quick initial pressure of steam in the cylinder, which is so much sought after by engineers.

The same that is true of the inlet of steam, is true also of the exhaust. The inside supplementary ports serve the same purpose for the exhaust steam in its exit from the cylinder. The

exhaust ports double as the valve travels, letting the exhaust steam out of the cylinder in half the time required by the common D slide valve. This gives the exhaust steam a soft melodious sound as it comes from the cylinder, indicating an economical use of steam.

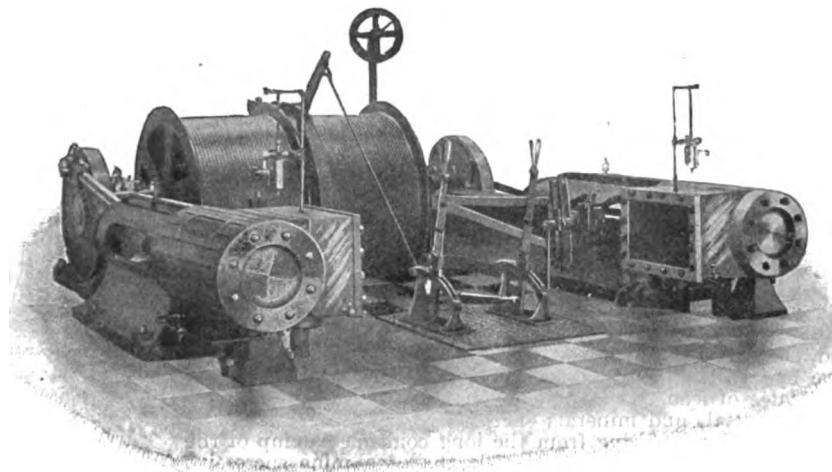
Springs are also provided on the back of pressure plate to permit it to lift a small distance from the seat, should the cylinder become full of condensed water.

The valves being in a perfect balance, the engine reverses as easily under a full head of steam as it does when the steam chests are empty. This is a very valuable feature in a hoisting engine, as it not only relieves the engineer from the arduous duty of reversing an unbalanced valve, but reduces the friction in the links and eccentrics to a minimum.

This engine being of a "straight line" design, valves perfectly balanced, reciprocating parts balanced, the engine may be run at a high rate of piston speed and a maximum speed of hoisting attained without any shock or jar to the machine. On all the larger hoists, a steam cylinder operated by a foot treadle is attached to the brake, which enables the engineer to run at a high rate of speed, and stop his engine at the desired point.

The piston rods and crank pins are made of close grained steel and accurately finished to standard gauges. The connecting rods are made of hammered steel and are similar to the rods used on locomotives, using both the bolts and keys with strap connection and are finished all over. Crank shafts are above standard size, and are made of hammered steel.

Links are made of cast steel and Norway iron and are finished to the proper radius by special machinery. The main bearings have a wedge adjustment, which gives an even bearing to the shaft. Drums are carefully turned and grooved for the proper



sized cable. Cross heads have adjustable brass shoes. Steam pipe and throttle valves are located beneath the floor, and operated by a hand lever. This arrangement takes the steam pipe away from the engineer, and insures drainage of the cylinders. Automatic drain cocks are used on the cylinders and a steam trap to carry away the condensed water is placed in the main steam pipe beneath the floor.

The cylinder heads, steam chests, cross-heads, connecting rods, cranks and all working surfaces are finished. Specifications and catalogues can be secured from makers.

The Hoepfner Electrolytic Process.

A plant to work the Hoepfner wet process for the extraction of copper was erected at Papenburg, Germany. It has a capacity, it is stated, of a metric ton of refined copper daily. The ore is first crushed in Grusonwerke ball mills and leached with cupric chloride solutions. The solution dissolves copper, lead, nickel, and silver, the cupric salt being reduced to the cuprous state. After purification and being freed from silver, the solution is allowed to flow to a compartment with carbon anodes and copper cathodes. Chlorine is liberated at the anodes regenerating the cupric solution, which is returned to a fresh charge of ore. It is claimed that 91 per cent. of the contained copper was obtained after four hours' treatment of Rio Tinto ore containing 3.37 per cent. copper and only 3 per cent. of the iron content dissolved. By longer contact 98.5 per cent. of the copper was extracted with only 4 per cent. of the iron taken up. It is claimed, moreover, that 1 H. P. in 24 hours will produce 54 kgs. of copper as against 15 kgs. by the sulphate process.—Kuhlows.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

**Mine Foremen's Examination Held at Terre Haute, Indiana,
March 21st, 1900.**

QUES. 1.—State what, in your opinion, are the necessary qualifications for a successful mine boss.

ANS.—(1) He should possess a thorough up-to-date knowledge of all mining operations, and of the different types of mine machinery, and of the application and adaptation of each class of machinery to different conditions. (2) He should be an intelligent judge of what a day's work in or about a mine consists; a good judge of human nature, and should possess care and skill in the handling of men. (3) He should possess firmness, self-control, and perseverance, and should be a man devoid of prejudicial opinions either with regard to men, machinery, or methods of working. (4) He should be fearless, prompt, industrious, observing, and always alert to the adoption of improved means or methods.

QUES. 2.—What are the duties of a mine boss as provided by the laws of Indiana?

Ans.—He shall (1) watch ventilating apparatus and airways; (2) see that loose coal and rock on the traveling and airways are secured against falling; (3) measure the air at the inlet and outlet and at the face of the entries once a week; (4) keep a record of such measurements and report monthly to the Inspector of Mines; (5) visit and examine working places each alternate day when men are or should be at work; (6) see that sufficient timbers are kept at working places; (7) order and direct that unsafe places be made safe when notified of them, and give written acknowledgment when he receives such notice; (8) give immediate notice to the Inspector of Mines when a serious or fatal accident occurs at his mine.

Ques. 3.—What experience have you had in and around coal mines? Name the different capacities in which you have worked and state the time you served in each capacity.

ANS.—This is a question of fact, to be answered by each candidate according to his experience.

QUES. 4.—We own a tract of land several hundred acres in area, which is underlaid with a vein of bituminous coal five and one-half feet thick, at a depth of 100 feet from the surface. The vein is overlaid with a gray shale roof of good quality, and is

underlaid with a hard sand grit bottom. We wish to open a mine on this tract of land which will insure us an output of 1,200 tons per day, and at the same time win out or remove as large a percentage of coal from the seam as is consistent with good mining. Describe in full how you would open and equip this mine to secure the above result, beginning with size of shaft, shaft bottom, shaft pillars, plan of workings, width of entries, rooms, room pillars, size of mine cars, tracks, mode of ventilation, etc.

Ans.—The size of the hoisting shaft depends upon the size of the

mine car to be used; the size of the mine car is determined by the output and the number of cars which it is possible to hoist in a given time (say one hour), and is modified by the thickness of the seam and the kind of roof and bottom, since in thin seams low shallow cars will be required, and with frail roof or soft bot-

tom narrow cars are often necessary. At a depth of 100 feet possibly three hoists could be made per minute; it will be better, however, to estimate upon two hoists per minute to determine the size of the shaft required. This will give for the weight of coal

per hoist, for an output of 1,200 tons in 10 hours, $\frac{1,200}{10 \times 60 \times 2} = 1$

ton per hoist. One ton of bituminous coal (broken) occupies, say

45 cubic feet (this will vary from 43 to 48 cubic feet according to the character of the coal). The thickness of the seam being $5\frac{1}{2}$ feet, we may adopt the car shown in Fig. 1, only reducing the height of the upper portion of the car from 24 inches as indicated, to 16 inches. If this car is then loaded 6 inches above its top, the area of cross-section of the coal will be 9 square feet, and the inside length of the car for a capacity of one ton (45 cubic feet) $\frac{45}{9} = 5 \text{ ft.}$ Allowing one foot at each end of the car beyond this di-

bumpers and clearance in the shaft, we have for the full width of the shaft in the clear $5 + 2 = 7$ ft. The length of the shaft will then be, as shown in the figure, 17 feet, making each hoistway $(5' 6'') \times 8'$, and providing a man or pumpway of $5' \times 8'$. This makes the full size of the shaft, in the clear, $7' \times 17'$.

Assuming a flat seam the shaft bottom should be driven each way from the foot of the shaft with a width of not less than 14 feet in the clear between timbers, for a distance of say 60 yards from the shaft, upon each side. The grade of the shaft bottom should be from 12 to 18 inches per hundred feet toward the shaft, or in favor of the loaded car. A general arrangement for the shaft bottoms, main haulage roads, air courses, stables, cross entries and rooms and the plan of ventilation are shown in Fig. 2. Iron plates are used in front of the cage upon both sides of the shaft to allow of cross caging when necessary. The width of the main haulage roads and of the cross entries should not be less than 8 feet and the entry pillars upon the main roads, say 5 yards for this cover, and upon the cross entries 4 yards in width. Rooms are turned to the right and left of each pair of cross entries, leaving a distance of 40 feet from the main entry to the outside rib of the first room. The rooms are turned narrow, 8 feet wide (if the coal is frail this width may be reduced to 6 feet), for a distance of 3 yards, and are then widened on the inbye rib at an angle of 45°. The roof and floor being hard and strong, breasts may be driven 27 feet wide with 13 foot pillars between them, making the distance from center to center of the rooms 40 feet. On account of the hard roof the room pillars should not be much less than 13 feet, even at this depth (100 feet). The mine should be equipped with a good pair of 12" × 16" second motion hoisting engines, having a 5-foot drum supplied with a good brake; the shaft should be equipped with iron cages, guides, wings, safety gates, safety catches being used upon the cages, etc. The ordinary form of tippie or dump may be used with upper landing, say 24 feet above the railroad tracks, and supplied with the requisite nut and lump screens and track scales for weighing lump coal. There should also be erected a good ventilating fan, which can be used either as a blow-down or as an exhaust fan. This fan should be located at the second opening, or air shaft, at a distance not less than 100 feet from the hoisting shaft.

QUEST. 5.—How many tons of mine run coal may be removed from the above mine before a second outlet is required by law, allowing that each cubic yard of coal will weigh a ton and making no deductions for impurities?

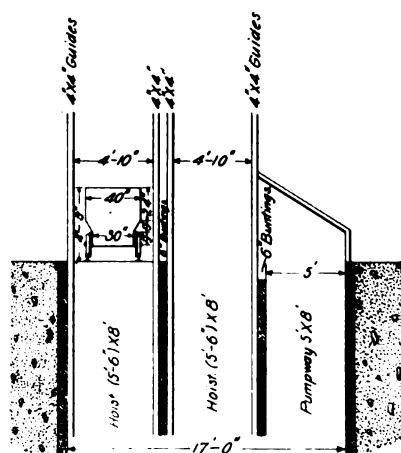


FIG. 1.

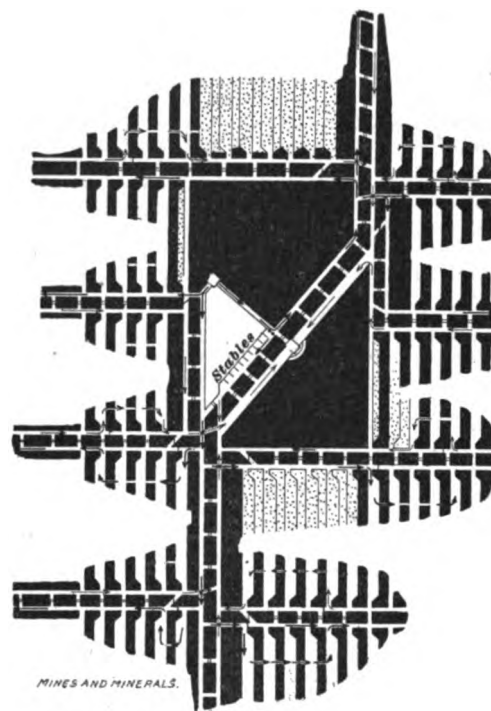


FIG. 2

Ans.—The Indiana Mine Law, as revised by the Act of March 6th, 1885, requires that a second outlet shall be provided to every mine before 5,000 square yards of coal area have been excavated, or prohibiting the employment of 10 persons in the mine thereafter until such outlet is made. Since the thickness of the seam is $5\frac{1}{2}$ feet the number of tons that may be removed before a second outlet is made is, $5,000 \times \frac{5\frac{1}{2}}{3} = 9,167$ tons, assuming that

one cubic yard of coal will weigh one ton. This does not, however, allow for any loss of coal in mining or that does not reach the surface; this loss may amount to anywhere from 2 to 3 per cent. of the entire weight of coal mined.

Ques. 6.—In providing the above outlet which would you prefer, a shaft or a slope? Give reasons for such preference; also your mode of sinking and timbering each, with difference in cost.

Ans.—The preference of a shaft or a slope for a second opening depends upon the conditions under which the mine is operated. A slope furnishes an easy traveling way for men and animals but has been objected to in many instances as permitting the men to go and come at all hours of the day and night, and to that extent interfering with systematic regulations in regard to working hours. The same objection may be urged against a shaft fitted up with a manway. In general a shaft would be preferred for a second opening at this depth (100 feet) when the seam is flat or does not outcrop. A shaft may be sunk cheaper than a slope for any given depth below the surface; it furnishes better facilities for ventilation and pumping, being the shortest and most direct means of reaching a seam from the surface.

The methods of sinking and timbering a slope in an inclined seam are much the same as those employed in entry driving. These are dependent upon the character of the strata passed through; when the strata are soft, timbering is needed and the slope is advanced by cutting and blasting at the face in the usual manner. When the material is very soft and crumbles, the method by over-poling must be resorted to at the face. Timber frames are set from 3 to 4 feet apart throughout the entire length of the slope, and lagging placed over these and at the sides to prevent caving. The size of timbers used will vary from 6" to 8" in diameter at the small end for round timber, to 10" for square timber, according to the character of the strata and the depth from the surface. The legs of the framing sets should incline inward with a batter of, say 2 inches to the foot. In over-poling, the timber frames are set close to the face and sheathing is driven over these frames toward the face to prevent the caving of the roof strata, as much as possible. In sinking a rock slope little or no timber is required.

In shaft sinking inclined or sumping holes are first drilled in the center of the excavation or shaft bottom. These holes are blasted first, so as to give the charges in the more vertical holes immediately back of these an opportunity to perform their work. For a description of the different methods of shaft timbering see article "Methods of Shaft Timbering," page 138, MINES AND MINERALS, October, 1900. The cost of sinking a slope in an inclined seam is practically the same as that of entry driving, and will vary from \$2.00 to \$3.00 per yard, or say \$1.00 per foot. For sinking a rock slope the cost will vary from \$2.00 to \$5.00 per foot for each 50 square feet of cross section, according to the character of the material. The cost of shaft sinking is greater, and will vary according to the material, from \$5.00 to \$40.00 per foot, in an ordinary sized shaft, when the excavation is 8' $\times$ 18'. The cost for shafts of smaller dimensions is somewhat increased on account of the limited space for the workmen, and the cost for larger shafts will increase according to the amount of material to be handled. These figures will usually cover the cost of framing and timbering.

Ques. 7.—There are three modes of ventilation now in use in Indiana, (i. e.,) the blowing and exhaust fan and the furnace. Name some conditions under which each of these three modes would have an advantage over the others; also the disadvantages of each. State which would be your preference under ordinary circumstances.

Ans.—(1) Furnace ventilation is an effective and cheap method of ventilation for deep seams and when no gases are present. A furnace is easily constructed and maintained, and its cost of operation is usually considered a small factor on account of the abundance of fuel at hand. Comparative tests, however, show that fan ventilation is more economical. The disadvantage in the use of a furnace under ordinary conditions consists mainly in the difficulty of starting the furnace fire after a short period of idleness. This difficulty is greater in some mines than in others owing to the large quantities of blackdamp generated. In gaseous mines the furnace is a dangerous means of ventilation; it must be supplied with a dumb drift to carry the gaseous current into the shaft at a point considerably above the furnace, to prevent ignition or explosion. Its use is always a menace to the safety of the mine.

(2) In the use of any form of fan the ventilation of a mine is more completely under control. The advantage of this form of ventilation consists mainly in the fact that the ventilating apparatus is at the surface, where it can be readily reached in case of accident or emergency. A second advantage consists in the ability to increase the amount of circulation quickly when desired. Fan ventilation is independent of the depth of the shaft as far as power is concerned, and is more efficient in shallow shafts on account of the decreased resistance of the shafts. A third advantage consists in the ability to change the direction of the air-current passing in the mine by reversing the action of the ventilator. The difference between an exhaust fan and a blow-down fan is practically very small, each being adapted to different conditions in the mine.

(a) The exhaust fan is adapted to the ventilation of gaseous mines where the intake airway is made the main haulage road, the fan being located over the air shaft, and the hoisting shaft being the downcast. The blow-down fan could not be used under these conditions, except it were located at or near the hoisting shaft; and doors would then be necessary at the shaft bottom, which would be generally impracticable. The exhaust fan is to an extent less efficient, especially in mines yielding a large quantity of firedamp, on account of working upon air of decreased density. This effect, however, is small in comparison with the practical conditions just mentioned and which alone should determine the use of the exhaust fan.

(b) The blow-down fan is adapted to the ventilation of mines where the haulage is performed upon the return airway, which is usually the case in non-gaseous mines, as well as in many gaseous mines where it is possible to render the return airways safe for haulage. There are numerous reasons why haulage may be better performed upon the return than upon the intake of a mine where this can be rendered safe. The blow-down fan is working upon pure outside air and under the increased mine pressure, and is to an extent more efficient than an exhaust fan. Under ordinary circumstances we would prefer to use the blow-down fan, in case the condition of the mine can be rendered safe to allow of haulage upon the return air-current.

Ques. 8.—Which should be the larger of the two, the blowing or exhaust fan, to obtain the same result? If you think there should be a difference, give your reasons.

Ans.—Of the two types mentioned the exhaust fan should be the larger, for like conditions in the mine, in order to circulate the same quantity of air by the same power. The difference between these two types, however, as previously mentioned is small and arises simply from the decrease in the density of the air in the fan. The exhaust fan is working upon air subject to a lower pressure than that of the atmosphere, while the blow-down fan is working upon air subjected to a higher pressure than that of the atmosphere. The gaseous condition of the mine air may be such as to increase or decrease its density, according as blackdamp or firedamp prevails in the mine; and an exhaust fan filled with air containing a large percentage of blackdamp may be often more efficient than a blow-down fan, since pure blackdamp (CO_2) is half again as heavy as air, having a density of 1.529. Since either of these conditions may be present or they may alternate, it is better to provide sufficient fan capacity for the worst condition possible.

Ques. 9.—How should the outlet to an exhaust fan be arranged so as to allow the air from the mine to be discharged freely?

Ans.—An exhaust fan running in a closed casing, or what is called a close-running fan, should have the casing surrounding the periphery of the fan, of a spiral form. This casing should begin to expand at a point about the distance between two blade tips from the cut-off, and should continue to expand uniformly, in the direction of revolution, all the way around the circumference of the fan to the cut-off, where the amount of expansion should be about one-fourth of the diameter of the fan. At this point the spiral conduit surrounding the fan should connect with the expanding chimney or outlet, whose height should be at least greater than half the diameter of the fan.

Ques. 10.—Describe how you would construct a good, cheap, durable brattice in breakthroughs on entries and in rooms.

Ans.—A simple efficient stopping or brattice for breakthroughs between entries is readily made by building a double wall of roof slate across the opening or breakthrough, which wall should be, say, 18 inches thick, and a space from 8" to 12" wide should be left between them. This space between the walls is filled with the fine dust taken from the roadways, or with sand and packed tightly to the roof. This form of stopping is very efficient and prevents any serious leakage of the air current. It is usually sufficient to stop all breakthroughs in rooms by a simple walling of the refuse of the seam, except in special cases where they are required to deflect the air to the face of the rooms for a considerable distance, and the face is difficult to ventilate, as in

the case of rooms running to the rise. In this case it may be necessary to use slack or fine dirt in the building of the walls for the stoppings. (See also, "Cheap Stoppings for Mines," page 237, MINES AND MINERALS, December, 1900.)

Ques. 11.—What are the effects of windy or blown out shots? How are they caused? What precautions should a mine boss take to prevent them?

Ans.—The immediate effect of a windy or blown-out shot is dependent upon the condition of the working face and the character of the coal in which the shot is placed. Where the coal is soft and inflammable, or the working face is not kept clean and tidy, there being accumulations of fine coal and dust, or where there is gas present in some quantity, the effects of a windy or blown-out shot are liable to be disastrous, and may result in an explosion of mine gases that may extend or propagate over a considerable area of the mines, according to the conditions prevailing in the airways and the working places, with respect to gases and accumulations of fine coal and dust. These effects are often increased by the explosion of powder in kegs left exposed in the working places or in the airways.

The causes leading to windy or blown-out shots are numerous. These causes may be stated generally as follows: (1) The charge is laid too deep or too far upon the solid. (2) The tamping or stemming is insufficient or of improper material. (3) The charge of powder is too great, or the size (grade of powder) is too fine, the powder is too quick or strong for the character of the work, or a mixture of different grades of powder has been used. (4) The diameter of the drill hole is too large for the amount of the charge or the work to be done, resulting in too great a pressure upon the stemming, which is consequently blown out. (5) Cracks or crevices in the coal connecting with the charge. (6) Two or more shots fired in quick succession in a close place, the flame of the later shots igniting the gases resulting from the explosion of the previous ones.

The most effective precautions to be taken to avoid these occurrences are a systematic and thorough inspection of all shots by a competent and authorized person previous to the firing of the same. Strict regulations should be enforced in regard to the storage of powder in the mines and working places, the amount and number of charges used in different holes, the drilling and stemming of holes, etc. All working places should be kept clean, and the fine coal and slack loaded out, especially where the coal is highly inflammable. In gaseous mines or where the conditions are urgent, all shots should be fired by competent and experienced shot firers after the men have gone.

Ques. 12.—Give in substance the law governing the use of powder in coal mines of Indiana.

Ans.—The act of the Indiana Legislature, approved March 4, '99, provides that there shall be no shooting or blasting during working hours, except in case of opening up a new mine which contains less than twenty employees, and is not worked over 100 yards in any direction from the shaft bottom, in which case shooting or blasting is permitted twice during working hours. No shots shall be fired in any working place or entry before all shots in places beyond such working place have been fired, and all workmen shall have passed the place in which the shot is fired on their way to the outlet of the mine. No more than 8 pounds of blasting powder shall be put into one hole for a single charge, and the firing of any hole known to contain more than this amount is a misdemeanor.

Ques. 13.—After opening the mine referred to in Ques. 4, we have decided to provide a slope for a second outlet, and we find that by beginning at the bottom and driving up, we can do the work much cheaper. We wish to begin at a point away from the shaft and drive the slope up toward it. The slope must be driven with a grade of 25 per cent. and reach the surface at a point one hundred feet from the hoisting shaft. How far from the bottom of the shaft must the slope be commenced?

Ans.—The seam being flat and lying at a depth of 100 feet from the surface, the distance to the floor of the seam would be $100 + 5.5 = 105.5$ ft. The grade of a slope is usually estimated as a percentage of its horizontal length; thus, a one per cent grade means a rise of one foot in each one hundred feet of horizontal distance, and a grade of 25 per cent means a rise of 25 feet in each one hundred feet of horizontal distance. It is sometimes understood, also, as meaning a percentage of the length of the incline instead of the horizontal length. Taking the meaning first given above, the horizontal distance in which a slope having a grade of 25 per cent will rise 105.5 feet, is $\frac{105.5}{.25} = 422$ ft. And since the slope is to reach the surface at a distance of 100 feet from the mouth of the shaft, we have $422 + 100 = 522$ feet for the total distance of the foot of the slope from the bottom of the shaft.

Ques. 14.—In a five-foot vein of coal we have an airway which measures 7 feet in width at the roof and 9 feet on the floor. The

anemometer shows a reading of 260 revolutions per minute. How many cubic feet of air are passing?

Ans.—The anemometer showing 260 revolutions per minute indicates a velocity of 260 feet in the airway, practically. Providing this is an average reading for this airway, the quantity of air passing per minute will be found by multiplying the sectional area of the airway ($\frac{7+9}{2} \times 5 = 40$ sq. ft.) by this velocity; thus, $40 \times 260 = 10,400$ cu. ft. per min.

Ques. 15.—In the opening and developing of a new mine what are the most serious questions to be considered?

Ans.—Before opening a mine the following questions should be carefully considered. (1) Where the output will be marketed. (2) Facilities of transportation to the market and the market value. (3) Competition of other mines with respect to quality and price. (4) Cost of operating and transporting to market, per ton of output. This cost should include the entire operating expenses of the mine, including cost of mining, dead work, drainage and ventilation, handling of the coal from the working face to the market, supplies, office expenses, superintendence and management, royalties, insurance, interest on investment, and sinking fund. (5) The labor required for the operation of the mine. (6) The extent of the coal field held or controlled by the company operating the mine.

In the development of a new mine it is important to decide upon (1) the method of working or the general plan of the mine. (2) The system of haulage or manner of handling the coal from the face to the shaft or slope bottom. (3) The plan of ventilation of the mine workings. (4) The drainage of the mine. (5) The manner of mining the coal and the use of machines at the face; the explosives to be used, manner of placing shots, support of roof at the face, width and direction of rooms, size of pillars, etc.

Ques. 16.—In a certain mine the coal seam is three feet thick and overlaid with a very strong roof. The bottom is fireclay and heaves badly. Eighteen inches more of height is needed on the haulage roads. State how you would secure this height.

Ans.—This seam would probably be mined upon the longwall system. Unless the roof is very hard the 18 inches of increased height for the roadways, should be taken from the roof strata. The entries should be made wide by keeping the main roadpacks back a distance from the track, upon each side. The roadways as first laid out should be 12 or 14 feet wide. As settlement takes place, the height of the roadways is maintained by brushing the roof over the track, and the material taken down is built up on each side of the road. The packs upon both sides of the road should be made wide, and care should be taken to induce a fall of roof as quickly as possible behind the working face, in the gob, in order to relieve the roadpacks and avoid the heaving of the bottom, as much as possible. A good drain should be maintained upon each side of the road close to the track, in order to keep the bottom dry and hard.

Ques. 17.—Describe how you would construct a good haulage road in a mine in which the bottom is very soft and making a great deal of water.

Ans.—The roadway here should be corduroyed by laying cross timber or ties close together under the track. The entry or haulway should be wide, say 12 or 14 feet, provided the roof can be supported, and a good ditch for drainage should be maintained upon one or both sides of the road as required, close to the track. The aim should be to keep the bottom dry and the track in good condition. If heaving of the bottom occurs, when the entry is wide this will probably take place at the sides more than in the center.

Ques. 18.—In a certain mine there is a pair of entries in which all of the rooms and entry faces are giving off gas so fast as to make them dangerous. Describe how you would keep the faces clear while driving from one breakthrough to another.

Ans.—Under these conditions the face of the entries and of the rooms can only be maintained free from gas and in a safe condition, by constructing a temporary brattice extending from the outbye rib of the last breakthrough forward along one side of the entry or room, say 2 or 3 feet distant from the rib of the same, to a point near the working face, as shown in Fig. 3, illustrating the answer to the next question. This temporary brattice is usually



FIG. 3.

constructed by setting posts from 4 to 6 or 8 feet apart, and nailing brattice cloth to these to serve as a partition to conduct the air forward to the face. As the opening progresses and another breakthrough is made, the brattice must be taken down and carried forward, as it is needed; by this means the air current is obliged to travel around the brattice and made to sweep the face.

Ques. 19.—What dangers do we meet in approaching old abandoned workings? What precautions would you take to avoid those dangers?

Ans.—There are liable to exist in such workings dangerous accumulations of water or gas, or both. Not more than one opening should be driven in approaching such workings. The width of the opening should not exceed 12 feet. Ventilation is maintained in the heading by means of a brattice set about 3 feet from the rib upon one side. Drill holes are bored in the gangway as shown in Fig. 3. One hole is kept in the face at least 20 feet in advance of the entry, and in line with the same; flank holes are bored upon each side in the rib each 8 feet of advance. The flank holes make an angle of from 25° to 30° with the line of the entry. In thick seams it may be necessary to use two rows or banks of these holes. A sharp lookout must be kept by the workmen for any increase of water or gas, as this would indicate proximity to danger. Plugs must be kept in readiness for instant use. Safety lamps only should be used at the face. (See article in MINES AND MINERALS, September, 1899, page 90, and December, 1899, page 236.)

Ques. 20.—How may coal dust explosions in mines be prevented? What is the effect of dust on a gas explosion in a mine?

Ans.—The best means of preventing explosions of coal dust in mines is to load out the dust and fine coal as it is made at the working face, and to clean the roadways of all coal and dust accumulating from the haulage of the coal from the face to the shaft bottom. Where the coal is soft and particularly inflammable, precautions should be taken in regard to the firing of the shots, the amount and number of charges employed, and the method of firing. The holes should be inspected before firing by a competent and authorized person. In gaseous mines the dangers arising from the presence of coal dust are much greater than they would be otherwise, and under these conditions competent and experienced shot firers should be employed to fire all shots after the men have left the mine. In all cases where the working face is particularly dusty, water should be used to sprinkle and lay the dust in the vicinity of shots, before firing the same; but reliance should not be placed upon this as a safe method and as justifying or rendering safe the accumulation of dust and fine coal at the face.

The effect of fine coal dust suspended in the air of a mine and acted upon by the flame of a blast or of a gas explosion, is to intensify and extend the flame of the explosion. The flame acting upon the dust suspended in the air distills from it carbonic oxide gas (CO), which is itself combustible, and in burning feeds the flame of the explosion. By this means an otherwise local explosion is transmitted or propagated, from one point to another in a mine; and isolated bodies of gas or kegs of powder may be ignited thereby, increasing the effects and enlarging the area of the explosion.

Ques. 21.—What should be the first points to be looked after by a mine boss, on entering a mine in the morning?

Ans.—Assuming that the mine boss has acquainted himself with the report of the fire boss, and has a full knowledge of the condition of the working places of the mine, his first duties on entering the mine are to assign the company men or shift hands to their several duties, at different points in the mine. If everything is in proper working order at the bottom, and the pumps or ventilating apparatus do not require special attention, he proceeds at once to the inside workings, having given orders that the bottom shall be cleared of any coal or dirt brought out by the night shift. He proceeds to first look after the work of the drivers, and arrange for the proper movement of the coal to make up the trips. When everything is moving satisfactorily and the coal coming regularly to the inside parting where the trips are made up, the boss is free to proceed to the working face. He should visit the rooms regularly, and see that each room has its proper supply of timber and air, he should also assure himself that the timber furnished to the rooms is being properly used, and should caution the men in regard to any top which he considers dangerous, acquainting them always, as far as possible, with regard to faults and slips which they are liable to meet.

Venetian Red.

Venetian red is a bright red pigment obtained by roasting iron sulphate or green vitriol. The sulphur is driven off, leaving iron oxide of a brighter red than that found native. The amount of iron so consumed is comparatively small when considered with the total iron product, and the venetian-red product is accordingly included in the output of mineral paints.

Calculations Pertaining to Pumps.

The simplest and clearest manner in which the work that a given pump will perform may be calculated, or the size of the steam and water cylinders determined, for the delivery of a given amount of water under a given head as follows:

Let p = mean effective steam cylinder pressure (lb. per sq. in.),
 D = diameter of steam cylinder (inches),
 d = diameter of water piston or plunger (inches),
 S = piston speed (ft. per min.),
 G = amount of water delivered (gal. per min.),
 h = entire lift of pump (ft.).

The power (foot-pounds per minute) of the steam end of the pump is given by the expression $.7854 D^2 p S$. The work performed (foot-pounds per minute) at the water end of the pump, assuming the weight of a gallon of water as 8½ pounds, is given by the expression $8½ G h$. The efficiency of the steam end may be assumed as $\frac{3}{4}$ or $\frac{2}{3}$, while the efficiency of a well-packed water end is usually taken as 85 per cent.

We then write for the equality of effective power and work, assuming 75 per cent. of the power of the steam end, to be effective at the water end,

$$.75(.7854 D^2 p S) = 8½ G h.$$

And again, for the equality of volumes, assuming the total volume of discharge per minute as 85 per cent. of the total volume of the water end per minute,

$$.85(.7854 d^2 S \times 12) = 231 G.$$

From these equalities, we have for the diameter of the steam cylinder,

$$D = \sqrt{\frac{8½ G h}{.75(.7854 p S)'}}$$

Diameter of water piston or plunger,

$$d = \sqrt{\frac{231 G}{.85(.7854 S \times 12)'}}$$

To determine the horsepower required, we write,

$$H. P. = \frac{.7854 D^2 p S}{33,000} = \frac{4}{3} \times \frac{8½ G h}{33,000} = .00034 G h.$$

If we assume the efficiency of the steam end as $\frac{2}{3}$ instead of $\frac{3}{4}$, as is sometimes done, the expression for horsepower becomes

$$H. P. = .00038 G h.$$

The claim is frequently urged against pumps of the reciprocating type, and as an argument in favor of centrifugal pumps or the new form of propeller pump recently being introduced, that there is a large loss of energy due to reciprocating action in pumping, notwithstanding the influence of the compression chamber of the pump. To understand how much of truth there is in this statement, and how far such influence goes to destroy the efficiency of pumps having reciprocating action, we write the expression for the acceleration of any system of resisting pressures, or where pressure is applied to produce motion against resistance, thus:

Let f = the acceleration (ft. per sec.),
 g = the acceleration due to the force of gravity (32.16 ft. per sec.),
 p_1 = total pressure acting to produce motion (lb.),
 p_2 = total pressure resisting motion (lb.),
 r = ratio of the diameter of the steam end to that of the water end $\left(\frac{D}{d}\right)$,

r_1 = ratio of the total water pressure per square inch, to the effective steam pressure per square inch $\left(\frac{.434 h}{.75 p}\right)$.

Then, $f = \frac{p_1 - p_2}{p_1 + p_2} \times g$. (See MINES AND MINERALS, page 522, June, 1900), but,

$$p_1 = .7854 D^2 p,$$

$$p_2 = \frac{.7854 d^2 \times .434 h}{.75}$$

and

This value given for p_2 is the total resisting pressure, including the total pressure due to the water column $(.7854 d^2 \times .434 h)$, and the pressure lost in operating the pump. Since the total pressure due to the water column or the effective pressure, is 75 per cent. of the total resisting pressure, the value of the latter is obtained by dividing the total effective pressure by .75. Making these substitutions in the formula for acceleration given above, and reducing, we have finally for the acceleration, the simple expression

$$f = \frac{r^2 - r_1}{r^2 + r_1} \times g.$$

It is not the intention here to intimate that the precise action, speed, etc., of a pump under the variable conditions of mining

can be calculated from this or any other formula; but the fact will not be denied that it is by the means of such formulas as these that we arrive at certain limits which make known to us the possibilities of the pump's action. For example, let us assume certain values representing the work of a given pump, and substitute these in the formula last given to determine the acceleration of the system, under such assumed conditions.

Example.—Find the acceleration in a $14'' \times 7''$ pump, stroke $10''$, discharging 300 gallons of water per minute, when the lift is 200 feet.

Solution.—Assuming an efficiency of $66\frac{2}{3}$ per cent. at the steam end of the pump we have for the horsepower,

$$H. P. = .00038 G h = .00038 \times 300 \times 200 = 22.8 \text{ H. P.}$$

$$\text{Then, } \frac{.7854 D^2 p S}{33,000} = 22.8.$$

Now, substituting values, assuming the piston speed (S) as 100 feet per minute, we have for the mean effective steam cylinder pressure necessary to produce the required power in this pump,

$$p = \frac{22.8 \times 33,000}{.7854 \times 14^2 \times 100} = 48.87 \text{ lb. per sq. in.}$$

$$\text{Then, } r = \frac{D}{d} = \frac{14}{7} = 2, \text{ and } r_1 = \frac{.434 h}{.75 p} = \frac{.434 \times 200}{.75 \times 48.87} = 2.37.$$

$$\text{Finally, } f = \frac{2^2 - 2.37}{2^2 + 2.37} \times 32.16 = 8.23 \text{ ft. per sec.}$$

Suppose, for a moment, the entire water column came to rest at the end of each stroke of the pump. The time required, then, to produce a piston speed of 100 feet per minute in the pump would be

$$\frac{100}{60 \times 8.23} = .2 \text{ sec., or } \frac{1}{5} \text{ of a second.}$$

As a matter of fact, however, the water column never comes to rest between the successive strokes of a double acting pump, even in the use of the single pump, and when pumps of the duplex or triplex pattern are used in connection with a good compression chamber the velocity of the water column is very slightly impaired. As a result the only loss of energy in the use of these pumps is a slight loss due to the weight of the moving parts. It is customary to allow for a velocity, in the delivery pipe of a pump, of, say 400 feet per minute or 4 times the piston speed of the pump. Now, assuming that, under adverse conditions, this velocity is momentarily reduced $\frac{1}{4}$ at the end of each stroke, then the time required to restore this lost velocity would be

$$\frac{1}{4} \times \frac{v_1 - v_2}{60} \times \frac{1}{f} = \frac{400 - 200}{4 \times 60} \times \frac{1}{8.23} = .1 \text{ sec.}$$

This pump having a $10''$ stroke and a piston speed of 100 feet per minute is making $\frac{100 \times 12}{10} = 120$ strokes per minute, and

$\frac{60}{120} = .5$ second is the time for each stroke. Even under these adverse conditions, we see that the original velocity of the water column is restored in $\frac{1}{5}$ of its stroke or when the piston has moved 2 inches. Such conditions are frequently obtained in the use of single pumps, or where duplex pumps are used having a single action, or in certain cases where the compression chamber is insufficient and there is a large loss of velocity due to contracted valves; but in the use of the better types of duplex, double action pumps, and of triplex pumps, the loss of velocity between the successive strokes of the pump is exceedingly small, and this loss is fully restored at the beginning of the stroke.

Lubrication.

Perhaps there is no subject of greater importance in the mechanics of mining than that of lubrication. Whenever two surfaces are rubbed together friction is produced and heat results. In earlier times a very common form of producing fire or light was through the agency of friction; smooth pieces of soft pine rubbed together at a rapid rate and under pressure were in common use as a means of producing flame. In the operation of machinery, however, friction is a very dangerous element, and is the direct result of a larger number of breakdowns than perhaps any other factor. Well designed journals under heavy pressure, poorly fitted bearings, or bearings lacking proper lubrication, produce at once friction and heat; and these combined factors if not given immediate attention, often lead to cutting and at times to the entire destruction of the moving parts.

It is not only necessary that the moving parts of any well designed piece of machinery should be accurately fitted to each other, but that they should be supplied with oil or other lubricant adapted to their use. The purpose of the lubricant is to maintain the surfaces of the moving parts at a slight distance from each other, in order that the roughnesses of these surfaces may not oppose each other's motion by coming in absolute contact. However well the surfaces of moving parts may be planed

and polished, the fact still remains that there is sufficient unevenness to create much opposition when these parts move upon each other in close contact. This is more especially true as the pressure holding the parts together is increased. In all cases the lubricant should be selected with distinct reference to its particular use, the nature of the surfaces it is to lubricate, and the speed and pressure of the moving parts.

Oils are derived from three different sources, and are accordingly distinguished, as to their general character, as mineral, animal, and vegetable oils. The mineral oils are largely represented by petroleum and its various products of distillation, and are obtained from mineral sources, principally by boring. The specific gravity of this class of oils is much higher than that of the fatty oils, either animal or vegetable, they also present less viscosity. The various products arising from the distillation of petroleum, which is the principal mineral oil, are numerous. Among the principal distillates, however, may be mentioned benzine, various grades of illuminating oils, giving finally a coal oil of 300° fire test, and neutral or non-acid oils. The last two products mentioned are much used in the manufacture of lubricating oils.

The fatty oils, or those derived from animal and vegetable sources, always present a lower specific gravity than oils derived from mineral sources. This fact often furnishes an important means of determining the amount of adulteration in lubricating oils. These oils do not evaporate at as low a temperature as the mineral oils. They present greater viscosity and power to resist heat, but combine also with their good qualities the ill effects arising from a tendency to gum and harden. Among the important animal oils may be mentioned lard oil, sperm oil, tallow oil, and fish oil; while representing the vegetable oils are resin oils, linseed oil, cotton seed oil, olive oil, palm oil, castor oil, etc. One of the distinguishing characteristics of all fatty oils is their peculiar odor or taste, by which it is possible to detect with considerable certainty their presence in a mixture of other oils.

The best results for lubricating purposes are obtained when the heavier products of petroleum are suitably mixed with the fatty principle of animal and vegetable oils. All fatty oils contain the fatty principle in an acid state; which renders them more susceptible to the action of the atmosphere, and increases their tendency to gum. In the manufacture of the better grades of lubricating oils, which comprise cylinder oils, engine oils, and machinery oils, the fatty oils contained in them are first subjected to a process of saponification by which their fatty acids are made to combine with a base, which renders them neutral oils, and destroys their tendency to gum, and thereby greatly increases their value as lubricants. When this product is combined with the later products of petroleum distillation, a lubricating oil is obtained that possesses the highest power to withstand the action of heat, combined with the required fluidity and viscosity which are essential in all lubricants.

The selection of a lubricating oil for any particular purpose is often a matter of much concern. No two oils will be found to lubricate exactly alike; one will present a greater viscosity than another; others will resist the action of heat due to high velocities and other causes; while still others offer greater resistance to the disintegrating influence of steam in the cylinders, valves, etc. of an engine. Some oils present less tendency to emulsion under the influence of hard water; some feed more rapidly than others, which often increases the cost of lubrication per horsepower. A good oil rightly used retains its character and is valuable for lubricating purposes after it has been in continuous use or until wholly absorbed or evaporated. The best lubricating oils may be filtered as they drain from the journal boxes and used over and over again as long as a drop remains, their value as lubricants being retained to the last. All of these characteristics and properties of the different oils should be carefully observed in the selection of a lubricant.

Much could be written as to the composition of different oils, but after all the true test of any lubricant is had in its application, in the engine room or workshop, to the purpose for which it is intended. This is the only test that will prove of value. Many laboratory tests are often given, the values of which are more or less doubtful. The practice of dropping different oils upon the cylinder chest and noting the time which they require for evaporation is not a comparative test, inasmuch as the oils so treated are subjected to a dry heat very different from the moist conditions in the cylinder. Among those laboratory tests which may be considered as having some value, are (a) The oils to be tested are placed side by side upon a clean glass plate protected from dust, and their tendency to gum or harden carefully noted. They may if desired be subjected to a uniform degree of heat to determine the time of evaporation, but this is of little value. (b) The comparative viscosity of the oils is noted by dropping each from a glass tube, the end of which is drawn to a narrow neck; the number of drops in a given time is carefully noted for each oil, which

shows their comparative viscosity or fluidity; or the glass plate in (a) is inclined, and the time noted for the oils to flow down the plate. (c) The specific gravities of the oils are determined by the hydrometer. This test indicates more or less closely the amount of adulteration of the fatty oils with mineral oil, although the accuracy of this test may be modified to a considerable extent if there has been an addition of resin oil for the purpose of reducing the gravity caused by the large proportion of mineral oil in the mixture. The addition of the resin oil is often difficult to detect on account of its having been carefully deodorized. A test of considerable value in the laboratory is that known as the *ignition and temperature test*. A small sample of the oil is placed in a dish over a lamp flame and the thermometer suspended in it. The temperature of the thermometer is noted as it rises, and from time to time a match is applied to test the ignition of the vapor arising from the oil. Mineral oils vaporize and the vapor ignites at a temperature varying from 110° to 300° F., while fatty oils require double this temperature for their vaporization. The amount of adulteration in applying the ignition test is determined by comparing the temperature at which the oil in question ignites with the ignition of samples of known mixtures of mineral and fatty oils. Those expert in the handling and testing of oils can detect the quality of the oil, and to a considerable extent the quantity of the ingredients present by the *taste* and the *smell*. In detecting oils from their odor a few drops are placed in the palm of one hand and briskly rubbed with the palm of the other hand, so as to develop some heat from the friction of rubbing. The oils give off their characteristic odor under this operation, and may be readily detected by an expert in the process. The test of pouring oil upon a blotter and noting the rapidity with which it spreads and evaporates, is of more or less questionable value in practice.

Aside from these laboratory tests the selection of a lubricating oil should be guided by the results obtained by a practical test of the power required to perform a given work in a given time in its use. If a cylinder oil is desired, the different grades of oils for this purpose must be tried in the cylinder in question, and the actual performance of the engine during their use carefully observed. If an oil is desired for the lubrication of the journals of an engine, or any heavy bearings, running at high speed, transmitting great power or subject to heavy pressure, a selection must be made with these ends in view; and the oils selected put to the practical test, while the consumption of power in their use, to accomplish the same results, is carefully observed and recorded. The quantity of oil used in the generation of a given power during a given time, will furnish the data for calculating the cost of lubrication per horsepower per hour; and this will determine the value of the oil for the purpose for which it is employed. The highest type of oil is that which furnishes the best lubrication at a minimum cost. The fact that any given oil accomplishes efficient and economical lubrication of the cylinders or the journals of a particular engine, is not an absolute guarantee that it will accomplish the same results in any engine working under different conditions. The only reliable test is that obtained in the actual use of the oil in the engine for which it is designed.

General Arrangement of Shaft Bottoms.

Upon the arrangement of the main haulage roads, airways, tracks, etc., at the bottom of a shaft, depends to a very large extent the successful operation of a mine. Too often it is true that, owing to the urgent demand for coal, or the desire to put the mine at once upon a paying basis and to obtain some income in return for the large outlay for sinking and equipment, an attempt is made to open out rooms and breasts in the coal, shortly after the shaft has been sunk and before a sufficient amount of entries have been driven to provide ample arrangements at the bottom of the shaft. To so large an extent does the future success of the mine depend upon these arrangements that it is no exaggeration to say that they are in themselves of as much importance as the shaft, and in no case should the coal be opened out, or breasts formed, until the entries are driven beyond the limits prescribed upon the plan, as required for the proper arrangement of the shaft bottom.

The term *shaft bottom* is often understood as referring to that portion of the main haulage road that extends in each direction from the foot of the shaft, and that is widened out to provide room for two tracks, the one an empty and the other a loaded track. In a broader sense, however, the term *shaft bottom* may be made to apply to all that area at the bottom of the shaft devoted to arrangements necessary for the continued operation of the mine. This would include generally the entire shaft pillar, embracing the hoisting shaft, air shaft, stables, pump room and portions of the main intake or air course, and haulage roads. The several items just mentioned include the main features of the shaft bottom in this broad acceptance of the term. It is evident that the area surrounding the shaft, and required for this purpose,

will vary in every case according to the prevailing conditions. For example, if the air shaft and hoisting shaft are both embraced in this area or sunk in the same shaft pillar, the distance of these two openings apart, which is often specified by the mine law, will form an important factor in determining the size of the area. Again, it will be necessary to consider also the depth of the shaft or thickness of cover, in determining the size of the shaft pillar, and also the thickness, inclination and character of the seam, and the character of the enclosing strata. It is no economy in the opening of a large mine to begrudge the area of coal set aside, in this pillar, for the protection of the shaft; since this coal can readily be reclaimed when the shaft is abandoned, and its presence will often be the means of saving the large outlay which would be necessary should a settlement of the strata reach the shaft.

It is our aim in the present article to draw attention to some of the leading points that affect the arrangements at the shaft bottom, and to submit one or two plans of such arrangements which may with some modifications be adopted in particular cases. We present Fig. 1, as illustrating one plan for the arrangement of shaft bottoms in flat seams. We also refer to Fig. 2, page 325, of the current issue as illustrating another plan, also in flat seams. It will be observed these two plans differ materially in the arrangement of the main haulage roads at the shaft. The reason for this is not evident from the plan; but its purpose is at once clear when we draw attention to the fact that, the direction of the surface tracks is seldom such that the shaft

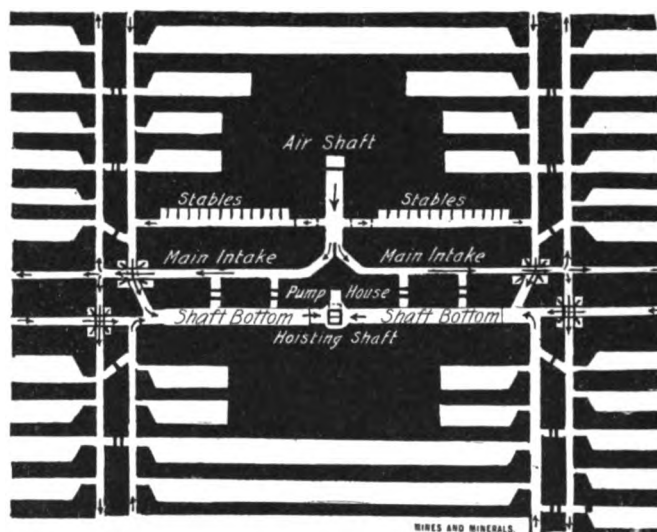


FIG. 1.

will set exactly east and west or north and south, or as we say, "square with the world," or have its sides parallel to the land lines of the property. It is of great importance that wherever possible the direction of the haulways should coincide with the general direction of the land lines. The observance of this rule greatly decreases the annoyance arising from the necessity of calculating the length of rooms driven toward a boundary, in order that they shall not overrun the land line of the property, in cases where the entry is not parallel to such land line. It is likewise important that the haulage road at the shaft bottom shall be in line with the shaft, and that the shaft shall be also square with the surface tracks, since any other arrangement, to a certain extent modifies the speed of loading. The consideration of these facts explains the form of diagonal shaft bottom shown in Fig. 2, page 325.

Size of Shaft Pillar.—It is not possible to give a hard and fast rule by which the necessary size of shaft pillars under any conditions may be determined. Numerous rules have been given by different authorities. Among the more important of these may be mentioned those of Merivale (Size of shaft pillar, yds. sq. = $22 \times \sqrt{\text{depth of shaft, fathoms}}$); Hughes (One yard in breadth of pillar, for each yard in depth of cover); André (35 yards square for depth of 150 yards or 450 feet. Add one yard for each additional 5 yards, or 15 feet in depth); Wardle (Minimum size 40 yards square for depth of 60 fathoms, or 120 feet. Add one yard for each additional two fathoms or 12 feet, in depth); Pamelly (Minimum size 40 yards square for depth of 100 yards or 300 feet. Add one yard for each additional 4 yards or 12 feet, in depth); Dron (Radius of shaft pillar equals distance from the shaft to farthest building to be protected, plus one-third of the depth of the seam). All these rules refer to flat seams. In July, 1897, THE COLLIERY ENGINEER

AND METAL MINER in an editorial by Mr. R. J. Foster, proposed a rule having reference to the thickness of the seam as well as the depth of the shaft, which is as follows: Radius of pillar = $3 \times \sqrt{\text{depth of shaft} \times \text{thickness of seam}}$ (all in feet). See COLLIERY ENGINEER AND METAL MINER, Vol. XVII, page 538. In October of the same year THE COLLIERY ENGINEER AND METAL MINER (see Vol. XVIII, page 117), reprinted an article from "Mining Engineering" presenting the following formula, as being adduced from examples in practice: radius of shaft pillar = $20 + \text{depth of shaft} \times \sqrt{\text{thickness of seam}}$ (all in yards). In inclined

seams it is customary to give a much greater radius of pillar upon the rise side than upon the dip side of the shaft. (See also Coal and Metal Miners' Pocket Book, 6th edition, p. 285.)

Length of Shaft Bottom, Double Track.—The length of double track necessary at the bottom of the shaft should be such as to accommodate two full trips in order to avoid blocking the main haulage road in case of delay in hoisting. The size of trips will depend upon the kind of haulage used and the distance from the shaft bottom to the inside parting where the trips are made up. It is not necessary, however, that the entire length of shaft bottom be opened out at first; this may be done as required in the development of the mine. The ultimate length of the shaft bottom upon either side of the shaft will be limited by the distance to the first pair of cross entries turned off from the main haulage road. This distance will usually vary from 60 to 70 yards according to the output of the mine.

Haulage and Ventilation.—Another feature determining to a considerable extent the arrangement of the haulage roads at the shaft bottom is the method adopted for the ventilation of the mine. This will depend largely upon the gaseous condition of the mine. In gaseous mines it is often unsafe to perform the haulage upon the main return airway, and for this reason in such cases the main intake of the mine is made the haulage road. The mine must then be ventilated with an exhaust fan, and the hoisting shaft made the downcast for the mine. This is necessary in order to avoid placing doors upon the main haulage road at the shaft bottom. In a non-gaseous mine haulage is performed preferably upon the return airway. There are several reasons for this arrangement; as for example, the movement of the loaded cars presents less resistance to the air-current; the dust and dirt incident to haulage is carried out of the mine by the return current instead of being taken into the mine to contaminate the air at the working face; the hoisting shaft being made the upcast is not liable to be impeded with ice in the winter season. The arrangement in Fig. 1, is applicable to either of these conditions, the only difference being in the direction of the air-current as shown by the arrows. The circulation in Fig. 1 is that of a non-gaseous seam ventilated by a blow-down fan placed at the air shaft, the hoisting shaft being made the upcast for the entire mine.

An important feature of the arrangement shown in Fig. 1 is the freedom afforded from doors upon the haulage road. As the development of each pair of cross-entries warrants the expense, an overcast is built at the mouth of each pair of entries; the overcast being built over the haulage road in each case, and leaving the same open for the free movement of the coal. In this arrangement the only doors necessitated in the entire mine are the doors dividing the back entry from the haulage road in each pair of cross entries; there are no doors upon the main haulage road and no doors closing off the stables, free access being had from the stables to the haulage roads upon each side of the shaft. It will be observed that while the haulage roads of each pair of cross entries are opposite to each other, their switches where they join the main haulage road do not interfere by reason of the inclined cross-cut driven in the main entry pillar.

Stables.—The location of the mine stables is an important matter in any mine. Such are the conditions in mining, that it is advisable in a majority of cases to locate these stables close to the foot of the hoisting shaft. In case of emergency the mules are more easily rescued, the daily feed required and the refuse from the stable are more readily handled, and the stables are better supplied with pure air and water at the shaft bottom than in any other location in the mine. It will be observed in both of the arrangements shown and referred to, the stables are ventilated by a split of fresh air off from the main air-current, by placing a regulator at the outbye end of the stable; this is simply a shutter in a door or partition. In case doors are used here, they should be double as shown in Fig. 1, but these are unnecessary as the other end of the stable connects freely with the haulage road, and the mules pass out that way. This arrangement will be the same when the current is reversed, in the use of the exhaust fan.

Pump House.—In Fig. 1 the pump house or pump room is shown immediately off from the manway-end of the hoisting

shaft. The exhaust from the pumps may be carried up the manway; but arrangements should be made, in cases where there is a liability of the formation of ice in the hoisting shaft, for the discharge to be carried into the hoisting shaft, when necessary to prevent this difficulty. If desired, when the air shaft is made the upcast shaft and the hoisting shaft the downcast, the steam line may be carried from the pumps up the air shaft; as this will greatly assist the ventilation of the mine when the pumps are running, and avoid the annoyance incident to discharging the exhaust steam into the hoisting shaft, which should not be done except as it becomes necessary as stated previously. The water from the pumps may likewise be discharged through the air shaft, if desired. The sump at the bottom of the hoisting shaft should be of sufficient depth to avoid the possibility of the pumps being drowned in case of break down or delay. Under ordinary conditions all of the pumping can be performed in two, three, or four hours per day; and the necessary repairs to the pump can usually be performed in the meantime, when the pump is idle. Notwithstanding this the sump should, if possible, be made large enough to hold a two-days accumulation of water. If necessary, a reserve basin or sump may be made at the air shaft or other convenient point in the mine.

Drainage of the Mine.—This is an important feature and should always be provided for in the early development of the mine; dry roads are a necessity, especially in fireclay bottoms presenting a tendency to heaving. The roads should all drain toward the shaft bottom, if possible; and where this is impracticable, sumps or basins should be arranged at necessary points to catch the water. In such cases siphon pipe lines can usually be laid connecting these basins with the main sump at the shaft bottom.

Examinations in Iowa.

The Iowa State Examining Board held an examination of candidates for mine foreman's and hoisting engineer's certificates at Ottumwa, Iowa, December 10-14, which resulted as follows: Enrolled for examination, mine foremen 66, hoisting engineers 39, total 105; of which 43 mine foremen and 24 hoisting engineers, total 67, received certificates from the Board. The examination was a fair and practical examination and was conducted in such a manner as to reflect credit upon the Examining Board. This is the seventh examination which has been held under the new law passed March 17th, 1900, requiring that all mine foremen and hoisting engineers in the State of Iowa should possess a certificate of competency or a service certificate, to be granted by the Examining Board. The law went into effect January 1, 1901. The work of the Board has been quietly and faithfully performed under conditions that were liable to cause some friction and not a little ill feeling on the part of those who were unable to secure certificates. Every opportunity has been granted to men throughout the State by the Board, who have tried to make the examination clear, simple, and practical. The result of the working of the new law will undoubtedly be observable in the report covering the next two years, in the reduction of the percentage of accidents and in the greater intelligence displayed in the general conduct and operation of the mines.

The Clays Associated With Coal Seams.

Of all the various strata associated with coal seams, perhaps none are as worthy of careful consideration on the part of the miner and mine operator as the clays. Nothing is more appreciated by the miner than a good roof and floor in a mine. By a good floor we usually understand a hard, firm stratum underlying the seam, although a few inches of mining dirt is always preferable and nearly always present immediately beneath the coal. It is almost needless to remark that the existence of the underclay of coal seams is almost as regular as that of the coal seam itself.

The features which characterize a good floor, however, do not necessarily make a good roof. The various characteristics that develop in the roofs of mine workings are more readily dealt with, and the dangers and difficulties arising from them combated than is possible in respect to the floor of the workings. A hard roof is not always a good roof. The overlying rock may be too hard to break over the coal pillars, and as a result the pillars are crushed by the superincumbent weight. The fact that a roof will stand unsupported over a large area is not to be regarded as a good feature in mining. The contrary to this is rather the case. The roof best adapted to mining operations, in the extraction of coal, is one of a uniform yielding character that allows of a gradual settlement, and distributes an even pressure over the supporting pillars. It must not be so yielding as to be frail or treacherous.

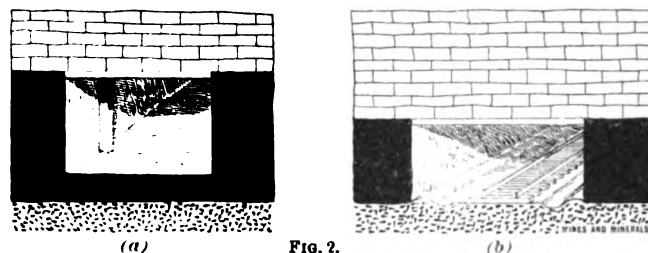
By varying the size of pillars and openings, in the extraction of coal, and employing different modes of timbering; or by the adoption of different systems of working, in general, the troubles arising from a poor roof may be overcome in a large

measure, whenever the roof strata consist of shale, slate, limestone, or even rock, the latter being generally the least preferable. The clays alone of all the various strata of the coal measures, present difficulties which are harder to overcome and characteristics harder to contend with than any of the other strata. This is to be explained from the fact that the clays in general are not so well formed, or have not the continuity possessed by the other strata. They do not possess any distinct lines of cleavage, being as liable to break in one direction as in another. On the other hand, shales, slates, limestones, and even sandstones and other rocks present greater regularity, and are more reliable as roof strata than the treacherous clays.

Each of these formations has characteristic cleavages, and the experienced miner is familiar with the manner in which all these forms of roof strata break. From a mining standpoint, although there are exceptions in every case, the characteristic features peculiar to each of these may be stated as follows: *Shales*, interlocking, laminated, or foliated structure, breaking in large cakes or slabs; *Slates*, laminated, jointed structure, breaking in slabs, and arching; *Limestones*, jointed fracture, arching; *Sand Rock*, stratified, uneven fracture, hard and unyielding, breaking in large masses. A knowledge of these characteristics peculiar to each form of roof, cannot fail to be helpful to the miner; but too often he is so preoccupied with the work of obtaining his coal as to give but a limited portion of his time to the study of the roof above him. To this fact is due the largest percentage of fatalities in mines. With the exercise of ordinary care and watchfulness on the part of the experienced miner, the number of fatalities from falls of roof could be easily reduced from 50 to 70 per cent.

We wish briefly to draw attention to some of the characteristics of the *clays* which, while they are for the most part familiar to the miner and mine operator as *facts* with which they come into daily contact, are not as well understood by all as they should be, and as a consequence less success and greater danger is encountered in dealing with them. One of the most troublesome features of clay formations in mining, aside from their treacherous

the floor will be kept dry, and what heaving takes place will probably occur for the most part at the sides. As a rule it is better in dealing with a clay floor having a tendency to heave, not to disturb the floor any more than is absolutely necessary, since when such a floor is once disturbed, as for example when bottom is lifted in the entry to give height or head room for the cars, heaving will generally take place to a greater extent than before.



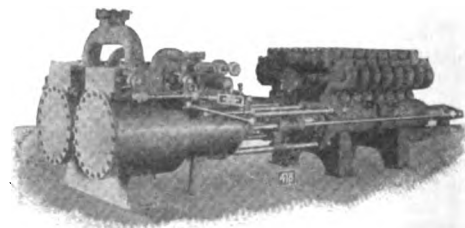
In such cases it is much better to brush the roof of the entry if possible, than to lift bottom.

Another troublesome feature characteristic of clays, and which often renders a clay roof exceedingly treacherous, is the tendency to jointing which is often manifest in such formations. The clay is then known as *joint clay*. The joints are short, irregular cleavages formed in the seam, at right angles to the plane of sedimentation and which correspond to the joints or cleats of coal seams, and give rise to a very dangerous roof for mining.

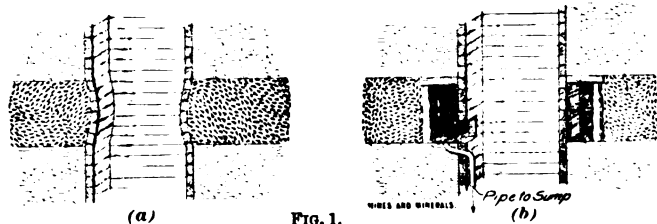
The clays found in close proximity to coal seams are usually of the finest quality for the manufacture of pottery and tiles, owing to their fine close grain. These clays are often mined in quantity in connection with coal seams, and are taken to the surface and there ground to an impalpable powder to furnish material for the manufacture of tiling and pottery ware. The under clay of a coal seam is often a good quality of fireclay, and as such is of great value in the construction of furnaces under boilers, and for the plastering of stoppings in the mine, and for other like purposes. In the use of this clay for the plastering of stoppings it has often been found beneficial to mix it with a brine or salt solution, which has had the effect of preventing to a large extent the cracking of the clay in drying. This is of considerable importance in the building of stoppings for sealing off mine fires, as such stoppings should be air tight.

Smith-Vaile Direct-Acting Pressure Pump.

The accompanying illustration shows one of the latest constructed compound direct-acting pressure pumps and one of the largest of its type built. It will be installed by the Columbia Gold Mining Company, of Oregon, and will be operated condensing. The pump was built for mine station work, the water end being designed for a working pressure of 600 lbs. per square inch, with ample margin for safety. The valves are of bronze of a special composition and type, seating on steel seats and located in individual chambers easy of access. The entire water end is made of a special semi-steel composition. An extension piece is provided with an adjustable shoe for the guidance and support of the plunger. The water plungers are of bronze and of the trombone type end packed, reciprocating through deep glands especially accessible. The entire water end is mounted on heavy cast iron foot pieces. The steam end is of the cross head type, lagged in polished steel. Steam valves are of the semi Corliss type, the area of ports for the induction and eduction of steam being especially liberal. The valve adjustment is on the outside. Special equalizing valves are provided, and the rock stand supporting the valve gear is located in such a manner as to least interfere with the inspection of the working parts and to obviate any trouble due to vibration. The crossheads are of a special type, being guided on the lower tie rod. Further particulars and prices &c. may be obtained by addressing the manufacturers, The Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio, U. S. A.



According to a recent writer in an English magazine the cost of mine haulage in Great Britain is 18 cents per ton of coal mined, or for the 250,000,000 tons mined per annum this amounts to about \$45,000,000 per year, or about \$15,000 per colliery.



nature and unreliability, is the action of some of the clays when wet. We refer now to those clays which so often are found forming the floors and not infrequently the roofs of mine workings, and which have the troublesome habit of swelling when coming in contact with water. Such clays usually contain a large proportion of lime in an anhydrous state (quick lime). The littoral conditions under which these clays were deposited furnished an abundant supply of lime, in the form of sea shells and sea life; and their later subjection to the heat of the coal formations has given to this lime and to the clays containing it, the character which renders them so troublesome. The property which quick lime possesses of swelling when mingled with water is well known in mining practice. It is this property which made lime cartridges so valuable for breaking down the coal, before the use of powder became general. The only salvation to the miner, in the treatment of such clay strata, is to keep water away from them, as far as it is possible to do so.

It is quite common in some mining districts to see shafts in a state bordering upon collapse, from this cause, as illustrated in Fig. 1 (a). In such cases, no system of timbering will avail to resist the force of the swelling of the clay. The remedy to be applied is that shown at (b) in the same figure. The clay seam is cut out all around the shaft and the excavation well timbered. A drain is cut in the floor or hard pan, and a pipe used to convey the water that accumulates to the bottom of the shaft, or other basin, from whence it is pumped to the surface. A good current of air is made to circulate around the space, which acts to keep the clay dry and hard.

In the mining of *thick seams* that are underlain with such clays as we have described, the method shown in Fig. 2 (a) is often employed. The lower bench of coal is left as a floor, and is taken up when drawing back, in the same manner as is often done in dealing with a frail roof, the upper bench of coal being then left, to be taken down when drawing back the pillars. In the mining of *thin seams* underlain with such clays, the only feasible method is to drive wide entries (Fig. 2 (b)), say 12 or 14 feet wide, and lay the track in the middle of the road. A good ditch is then carried close to the track upon each side. By this means most of

CAVE ORE DEPOSITS.

Illustrations of Peculiar Deposits of Silver and Copper Ores in Caves at the Red Mountain Mines.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

On our way from Silverton to Ouray in the San Juan Mountains we pass through the finest mountain scenery in Colorado. The rocks are composed of prodigious masses of andesitic breccia piled up in horizontal sheets into mountains two and three thousand feet above the valley, eroded into picturesque castles, towers and terraces, scored by the pathway of many an avalanche.

As we approach Red Mountain we are struck by the brilliant and even gorgeous coloring of the mountains, scarlet, gray, violet and maroon vying with the bright hues of the autumnal foliage, which at that season of the year clothes their flanks. The cause of these brilliant tints is doubtless to be looked for in a general oxidation of a minute mineralization of the district by iron-bearing minerals. When we pick up one of these (at a distance brilliant scarlet rocks) we are sadly disappointed in the dull burnt-sienna color which it has close to us. The brilliant colors are an example of the line:

"'Tis distance lends enchantment to the view."

In the neighborhood of Red Mountain these colors are particularly strong, hence the name of the district. In the little open valley in which the village of Red Mountain is located stands a prominent isolated castle rock about 300 feet in height, the top part of which is composed largely of quartz in a columnar form and intersected by numerous minor veins of quartz which would appear to meet in a general center. The columnar sides of this mass are honey-combed and riddled with little caves and caverns. On the largest of the fissures intersecting the hill on the northeast side, the original National Belle mine was opened in a fissure full of cavities and containing large bodies of kaolin and decomposed ore of various kinds. When I first visited the mine some years ago, they were digging out the decomposed ore with pick and shovel, and mainly with a shovel. Not a shot had as yet been let off in the mine. I crawled in with the foreman through various cavern-like openings, and we had to be very careful not to shake down masses of decomposed ore and kaolin from the roof and sides, whilst it was difficult to keep our footing from the slippery kaolin and decomposed ore lying at our feet. They were at the time shoveling out brown mud and drying it on a big iron pan and shipping this rich dried mud in sacks. This was the beginning of the celebrated mine called the National Belle.

On our visit lately we saw no smoke issuing from the extensive works. The mine had reached sulphide ore of pyrite and zinc at considerable depth. There are several of these isolated hillocks or chimneys of quartz, or aggregates of quartz veins, in the vicinity which mark the site of several other noted mines, very similar in their peculiar characteristics to that of the National Belle. It would seem as if they were the isolated throats of ancient geysers or hot springs that once dominated that very volcanic region.

Close to Ironton, a few miles down the canyon, is another remarkable "cave mine" called the Jedd. We visited this also in years gone by when it had just been opened. A funnel-shaped opening opened right up to the surface. It is said that the mine was first discovered by a hunter, who in winter time fell suddenly through the snow and found himself at the bottom of this cavity with minor cavities surrounding him on the sides full of decomposed silver bearing ore. We were let down into the cavity by a windlass and bucket and saw on the quartzose walls numerous cavities, either full or empty of ore, whilst many rat holes or rabbit-hole-like cavities ramified off into the rock. We emerged from the pit by a hole on the side of the mountain. Since our first visit an important mine has been established on the spot.

As typical of these mines located on these irregular knobs or chimneys of quartz, Mr. T. E. Schwartz, formerly Superintendent of the National Belle Mine, at Red Mountain, gave a detailed

description of this mine to the Denver Scientific Society, from which we gather as follows:

THE NATIONAL BELLE MINE AND OTHER RED MOUNTAIN DEPOSITS.

The district was the scene of ancient mineral spring activity. Its ores filled such water channels forming a section abounding in ore chimneys of irregular occurrence, great vertical depth, and small horizontal section.

The Red Mountain district occupies a basin at the head of Red Creek. The formations on the two sides of Red Creek are dissimilar. On the east side, on which are the mines, the Red Mountain shows a rough exterior, with jagged cavernous cliffs, long stretches of slide rock, and bright red colors. A series of benches is also noticeable on this side, forming the base of the mountain to a height of 400 to 800 feet, characterized by quartz outcrops. At the South end of the district two small parks occur, surrounded by these massive outcrops, marking the location of many of the producing mines. These outcrops form knolls 200 feet above the surface. Many present a pyramidal appearance, with a cliff of hard blackened cavernous quartz for apex. The west side of Red Mountain Creek has slaty colored cliffs and no bright red or heavy outcrops.

The Red Mountain district has been the scene of intense metamorphism. The andesite is bleached over large areas full of kaolin and breccia and pyrite. The white soft rock with kaolin faces encloses most of the Red Mountain ores. Massive knolls of quartz, or silicified andesite, occur. These in the National Belle, and other mines, are penetrated by caves and irregular passages, sometimes 40 by 60 feet wide, filled with iron oxides, white kaolin and ores of secondary deposition. These caves branch out towards

the surface from large chambers, and come together and diminish in size with depth.

Their formation was along cleavage and fracture planes affording passage for surface waters. They extend down to the water level 200 feet below the outcrop. The walls are smooth and rounded, porous, siliceous soft rock.

The ores of the district are: Surface ores of secondary formation. Sulphide ores occurring below the water level.

The first are found in caves adhering to the walls on masses of stalactites, or else as loose sand carbonates, or a clayey mixture with kaolin. Heavy spar and detached

masses of ore and rock fill the caves to a greater or less extent.

The ores of the National Belle carry a heavy per cent. of lead, from 30 to 50 per cent. in carload lots. They occur as sulphides in coarse crystalline masses attached to cave-walls or altered to a massive sulphide, or carbonate, with the sulphide only as a central core. With these are lead arsenites, limonite, zinc blende and much kaolinite; the latter snow white, each grain a perfect crystal.

The zinc blende in the National Belle occurs in botryoidal masses of concentric fibrous layers detached from the cave walls, lying in masses of kaolin on the bottom, or sides of the caves. They are sometimes a foot in diameter.

Adjoining caves vary considerably in gold and silver contained in these ores, whilst the coarse cube galena is usually lowest and the dark carbonates the highest grade ore.

East of the National Belle lies a group of mines similar in character, but differing in their ores, which contain considerable sulphide and oxide of bismuth in the cave ores. This ore in the Enterprise carries 25 per cent. bismuth, from which has been reduced several hundred pounds of metal 98 per cent. fine. This is the first large lot of metallic bismuth reduced on this continent.

The ores of the second class make the bulk of the Red Mountain production. In properties producing the oxidized ores, peculiar to caves, the unoxidized ores begin at water level, where the cave ores cease. In other properties, in which the cave formation is not present, the latter class of ores outcrop on the surface.

There the quartz knolls do not occur. These ores are sulphides and sulpharsenides producing galena, copper and iron pyrites, erubescite copper, bismuthinite, enargite, and gray copper. Associated with these ores are rhodonite, or silicate of manganese,



NATIONAL BELLE MINE, RED MOUNTAIN, SAN JUAN, COLO.

A, Column of Quartz and Porphyry; B, Tunnel; C, Cave in Ore Chamber; D, Bright Red and Yellow Rocks; E, Lava-Terraced Mountains.

gypsum and heavy spar. A peculiar mineral, or ore, found in these mines, is hubnerite, which is a dark brown, or grayish black mineral, with a sub-metallic luster, occurring in long blade-like crystals. It is a manganese wolframite, containing no iron.

In the upper or southern portion of these mines enargite occurs massive, and is the prevailing mineral below the horizon of oxidation, varying greatly in silver contents from 15 ounces to 150 ounces per ton, associated with low grade iron pyrite and zinc blende with lead or bismuth sulphide.

In the northern or lower portion of the district are the two heaviest producing properties, the Yankee Girl and Silver Bell, near to the Guston, Paymaster, and Genesee. High-grade ores of the Silver Bell are characterized by bismuth, whilst in the Yankee Girl stromeyerite (sulphide of copper and silver), is the principal mineral. The surface ores of the chimneys in this portion of the district are either galena or pyrite, or copper pyrite.

The change in character and grade of ores is sometimes rapid, particularly in following the ore chimneys in depth owing to these sudden and irregular changes of pitch. The prominent features of these occurrences are:

1. The ores occur in chimneys with small horizontal section, more or less circular, and not more than sixty feet in diameter.
2. These chimneys consist of ore and its matrix, usually a fine grained brownish, or grayish quartz, often very porous. The ore is concentrated in one portion of the chimney, or embraces the whole of it, occurring massive, and free from gangue, for long distances.
3. The rock enclosing the chimneys is soft white andesite occupying large areas, separated from each other by hard, fine grained blue-green "blocky" diorite, the latter destitute of ore.
4. Individual chimneys occurring in ore, are of "white rock," showing no relation to each other, beyond a similarity of ores or a gradual drawing together in depth.
5. Chimneys separated by areas of diorite are foreign to each other and show dissimilar ores.
6. Change from "white rock" to diorite has no regular course.
7. Ore chimneys often change their pitch suddenly.
8. Every chimney is connected with one or more cleavage or fracture planes, generally vertical.
9. Changes in direction or pitch accompany an enlargement of the chimney.
10. The alteration of the enclosing rock increases as the ore chimney is approached, more silver occurs, and cleavage faces with large or small masses of kaolin.

Instances occur of marked increase in grade of ore from surface to considerable depth. In the caves the reverse often happens. Ores in caves are richer than the unoxidized ores immediately below them. The mines by no means grow richer with depth.

Copper and bismuth are the main enriching elements, and iron and lead the poorer. Car loads from Yankee Girl returned at times 3.5 ounces silver to ton with 30 per cent. copper. The Silver Bell produced in large lots, bismuth ores, milling 500 to 1,000 ounces in silver to the ton. The bulk of the Red Mountain ores from a depth of 200 feet carried 5 per cent. to 20 per cent. copper.

The district, as we have said, has been one of great activity of heated mineral solutions, which have deposited their contents along nearly vertical channels, and such channels were formed along planes produced by cooling of heated rock masses, or by some near dynamic movement. Owing to the structure of the rock, with its network of planes, the circulation of these solutions must have been comparatively rapid, the strong horizontal planes forming drainage courses for large areas collecting their mineral contents. Ore solutions might be expected to play an important part in determining the character of the ores in the chimneys with which they are connected. The alteration of the country rock and the deposition of the ores was a simultaneous process. The general merging of ores into rock on one or more sides of the chimneys, and gradual change of the hard quartz into soft andesite, together with the presence of kaolin in and adjoining the ore would indicate this.

The absence of extended fractures of the formation having considerable lateral persistence accounts for the non-formation of fissure veins. The nature of the rock and the forces governing the subterranean circulation of mineral solutions favored their concentration at points of least resistance along vertical planes.

In their passage upwards a gradual deposition of mineral contents and a replacement of portions of the adjoining rocks took place forming chimney-shaped deposits lacking in the confining walls and resulting regularity of fissure veins. The carbonate ores result from action of surface waters upon original sulphides changed to pyrite galena, etc., found below, concentrating the silver and lead, other constituents being carried off in solution.

The oxidizing and dissolving properties of these surface waters, account for the formation of caves along cleavage and fracture planes and the re-deposition of ores upon these walls.

Accidents in Mines.

By George Farmer.

In a recent paper read before the Institution of Mining Engineers in England Mr. Farmer said: To carelessness and disregard of the rules and regulations are traceable many of the casualties reported; and probably the best prevention for them is care. Mine discipline cannot be enforced too much, nor can carelessness be emphasized too often.

Coal-mining is a more dangerous calling than the average, but it requires only a glance at the reports of H. M. inspectors of mines to convince one that its dangers are greatly increased by the distressing lack of proper co-operation on the part of the workmen with the efforts of the employers to provide for the safety of life and limb. Probably in nine cases out of ten, the provisions made for the protection of the men while at work are sufficient for any known contingency. It is passing strange that many men seem unable to realize the importance of obeying the regulations set down for their safety. The intention of all mining laws is, of course, to render the work of the miner as safe as possible, and in order to maintain the necessary discipline every transgressor should have meted out to him "the punishment to fit the crime." Through a mistaken sympathy for the workman and his dependents, an offense may be allowed to go without other rebuke than a verbal one, or left unnoticed. This is wrong: the bars once let down, the whole fence of rules becomes valueless. Managers when besought to think of an offender's innocent family, should not fail to think of the equally innocent families of the many men whose lives were put in danger by the offence. The greatest good to the greatest number is a principle that should be applied in all such cases.

In summing up, the writer makes bold to suggest that absolutely the best preventive for colliery accidents is technical education. There is no possible reason why every colliery village should not have its mining classes; there is no reason why technical education should not be taken advantage of by all to the fullest extent, and this would enable workmen to better fulfil their duties in and about mines. The great aim of technical education is efficiency and safety; and efficiency and safety depend not so much on the managing director or manager as on the actual workers themselves. It is not enough to know that a certain lamp is comparatively safe, and that another lamp is not safe; every miner ought to know why some lamps are safe and others not. It is not enough to know that certain accidents occur in mines, every miner ought to know what the causes of these accidents are. Technical education teaches this. It teaches a man the use of his labor, how to do his work safely, and how to do it in the most economical manner. It has often been said that there are already more managers than mines. What is the harm in that? The mine would be no less safe if every miner in it held a first-class certificate of competency. The writer is fully aware that many, sadly too many, miners think they know more than other men can teach them if they know how to swing a pick, or set a prop. They ignore or ridicule the manager if he invites them to a mining or ambulance class; but they heartily sing "For he's a jolly good fellow," if he invites them to drink his health. Then how are we to instil education into the minds of such men? We can do it. To educate his workmen should be a colliery manager's aim and pleasure. He should not stop at a mining class once a week. He can reach many of his men in the mine. He can point out deficiencies, he can instruct in his orders, he can explain the why and wherefore of many things to the workmen, and, by these simple and easy means, incite such a thirst for knowledge that the workman will thank him by seeking it. The writer does not mean to suggest that lectures should be given in the mine. The mine is a place for work, and lectures are best delivered in the lecture-rooms.

The writer cannot let this opportunity pass without a word on ambulance work, or first aid to the injured. Ambulance work cannot be directly called a preventive of accidents, but it is certainly useful; and the classes should be attended by every man in the mine, whereby he may learn to render first aid so as to assuage pain, lessen danger from injuries, and save life. Classes should be held every year in every mining village, and the workmen and officials should be specially invited to attend by the manager of the mine. No colliery-manager should be satisfied until he had at least one competent ambulance-man in each stall. Trained nurses, in the colliery-villages, might do great service in cases of serious injuries, and might be the means of saving life.

A mining engineer has two great objects. The first is to work his mines with the least possible loss of life or injury to the workmen employed by him. The second is to produce the minerals he is working at the least possible cost, having his first object, safety, always in view. In seeking these two objects he must, in a sense, have the co-operation of his workmen, and that is only gained by social influence, and, by means of instruction, making his workmen not mere machines but thinking human beings.

NEW INVENTIONS.

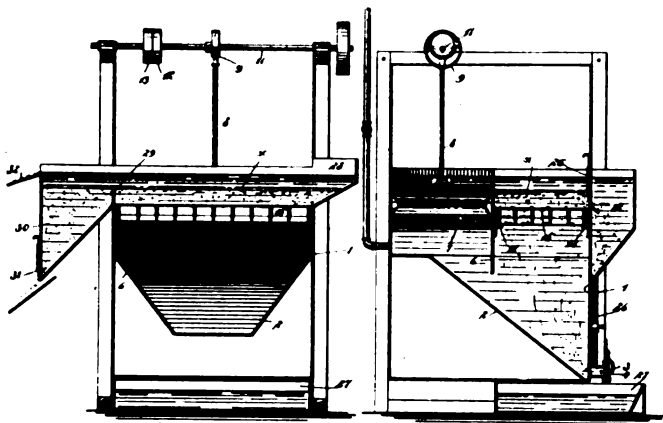
EDITED BY H. M. LANE, M. E.

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SLIME JIGGING MACHINE.

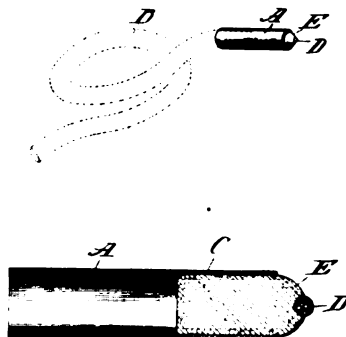
No. 660,869. C. B. ROGERS, EL PASO, TEXAS. *Patented Oct. 30, 1900.* This jig is made entirely from metal and consists of a frame or box 1 carrying the jig body 2. The shaft 11 is supported by a framework as



shown and carries tight and loose driving pulleys 12 and 13 and eccentric 9. This eccentric operates the plunger 7 by means of the rod 8. The plunger 7 imparts a pulsating motion to the water. The portion of the jig containing the water is divided into two compartments by means of the partition 6. The pulsations caused by the plunger pass under the partition 6 and are deflected up through the screen 15 which is supported in a suitable framework carried by the angles 18. The material is introduced onto the jig at 28 and flows across the top of the jig toward the tailings discharge at 29. *x* shows the usual height of material upon the jig. As the material flows across the surface it is subjected to the pulsating action of the water so that the fine and heavy materials pass through the screen and are discharged through the opening 3, controlled by a valve 4. There is also a discharge through an opening in the side of the jig controlled by the sliding valve 25 which allows any relatively coarse concentrates to pass into the compartment 22 from which they are discharged to the pipe 26. The tailings pass over the dam 29 into the compartment 30 and are allowed to flow away through an opening controlled by the valve 31. Any excess of water passes over the discharge 32. The concentrates from the discharges 3 and 26 are collected in a pan 27, from which they are periodically removed. The inventor claims, as its name indicates, that this jig is intended for working very fine materials or slimes only.

FUSE IGNITER.

No. 660,220. J. T. NAGLE, BUTTE, MONT. *Patented Oct. 23, 1900.* This invention provides a device for igniting fuse without the necessity of using giant powder or similar material. The figure shows the igniter attached to the end of a fuse B, the igniter being composed of a metallic shell A,

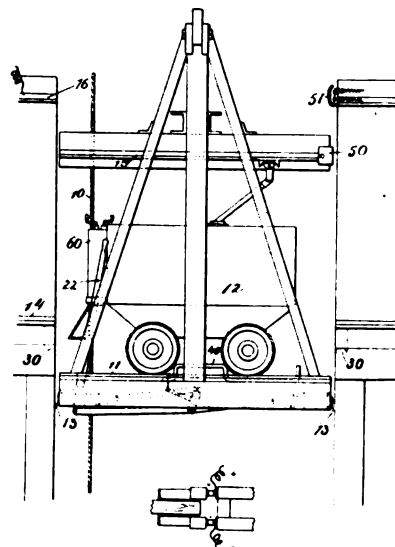


which is also shown in section; C represents a filling of highly inflammable material which is placed in the end of the shell. The end of this plug or filling of inflammable material is allowed to project as shown at E and in the center of this projection there is a friction match head D. The shell A is slipped over the fuse and secured in place by crimping. The fuse is lighted by striking the match head D. The end E and the match D may be covered with a coating of paraffin so as to protect them from dampness. The filling C must be of such a nature that it will burn without air, that is, furnish its own oxygen; in other words, it must contain materials which will give up oxygen freely, in addition to the combustible ingredients.

ELECTRIC CONVEYING AND ELEVATOR APPARATUS.

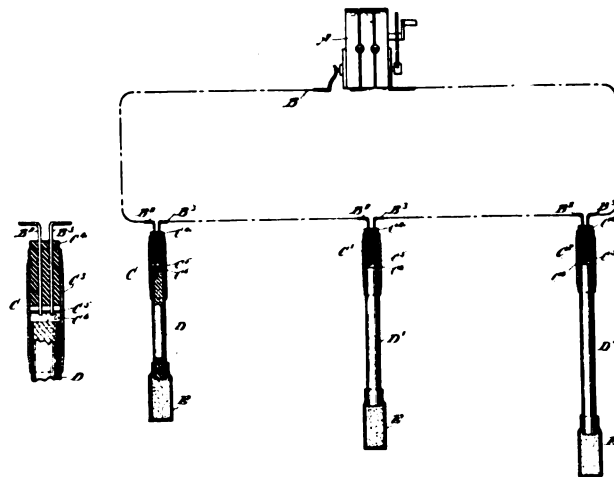
No. 660,724. G. K. FISHER, SALT LAKE CITY, U., AND F. KLEPETKO, GREAT FALLS, MONT. *Patented Oct. 30, 1900.* This invention covers a special design of elevator intended for taking electrically operated cars

from one level to another by means of a power elevator so arranged that the motorman can operate the lever without leaving the car and at the same time provide means for preventing the car's moving while on the elevator. The different parts are illustrated in Fig. 1, 12 being the electric car which is supported upon the elevator platform as shown. The rails 11 on the platform are so arranged that when the elevator is at one of the landings these rails are continuous with the rails 14 at the landings. To accomplish this, latches 13 are so arranged that they can be forced into pockets 30 when the platform arrives at the landing. These latches 13 are operated by means of the lever 22 connected to the latches by suitable links and levers. 60 represents the electric controlling mechanism for the car, and it will be noticed that when the car is in place on the elevator the lever 22 is within reach of the operator as is also the rope 10 which controls the motion of the elevator. The rails 15 on the top of the elevator are arranged so that they connect with the rails 16 of the regular system when the elevator is at a station or platform. The spring contacts 51, coming against the plates 50 furnish the current necessary. When the elevator is at any other position than at a station or landing the connection between 50 and 51 is broken and hence there is no danger of the car's moving itself. The car 12 is locked in place upon the elevator platform by means of the piece 40 which can be thrown between the wheels and the car. This piece 40 can be so arranged that it is operated by the lever 22 and is thrown out from between the wheels when the latches 13 of the landing dogs are thrown out at a station or landing. The invention covers the methods of locking the car upon the elevator, landing dogs for the car and the breaking of the contact between the trolley rails upon the elevator and those at any landing when the elevator is thrown into action, also the arrangement of the various parts so that the operator can control them without leaving the car.



BLASTING.

No. 663,724. C. F. BRYANT AND C. H. BROWN, CRIPPLE CREEK, COLO. *Patented Dec. 11, 1900.* The object of this invention is to provide a means by which a series of blasts can be ignited by electricity so that the shots will explode consecutively, allowing each shot to be counted

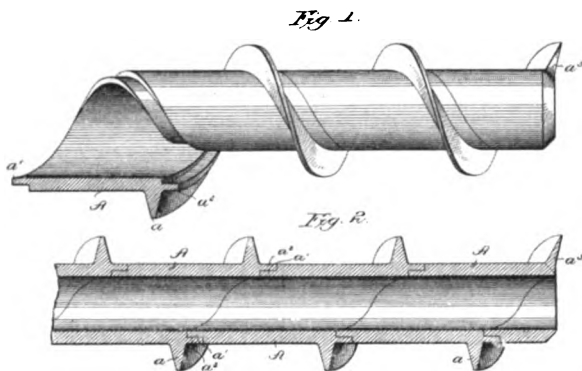


and at the same time so arranging matters that the shots will discharge in the most advantageous order. The two accompanying figures illustrate the various points covered by the patent. In place of connecting the wires to a cap and primer, as in the case of ordinary electric blasting, the wire B from the battery A is connected to a series of igniters C, C', C'', C'''. These igniters are connected to fuses D, D', D'', D''' of various lengths, the ends of the fuses being fitted with caps E for exploding the charge in the ordinary manner. By regulating the length of the fuse between the igniter and cap or detonator, the order of firing the shots can be regulated. The igniter is shown in detail at the left of the figure

and consists of a metal shell C^3 fitted with an insulating plug C^4 . The wires B^2 B^3 pass through this plug and the ends of the wires are joined by a thin piece of tin foil, or other thin metal, shown at C^5 . In contact with this metal there is a charge of gunpowder C^6 which serves to ignite the fuse D . When the current is passed through the two wires, the thin metal is either melted or a spark jumps across between the wires which ignites the powder in the igniter and so lights the fuse.

COAL DRILL.

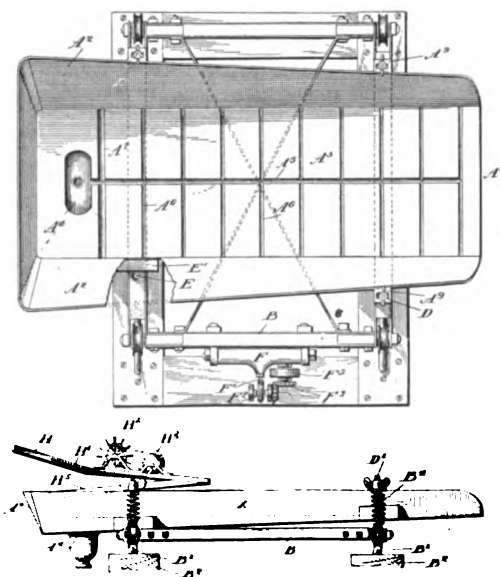
No. 662,646. M. HARDSOEG, OTTUMWA, IOWA. *Patented Nov. 27, 1900.* Fig. 1 shows the drill stock partially completed. The drill is made up by taking a strip of metal of the cross-section shown at A and rolling it



into a helix as shown in the right hand portion of the figure. This metal is provided with a triangular projection a which forms a spiral about the drill and serves to feed the cuttings out of the hole. The center of the drill receives a core of coal which may be removed after the drill is drawn from the hole. The cutting edge is provided by grinding the end of the spiral as shown at a' . One advantage claimed for this drill is that it does not require any blacksmithing work or dressing, but may simply be formed on an emery wheel or grindstone. Fig. 2 shows a section of the drill showing the cross-section of the metal at A , the cutting lip at a' , the spiral projection at a and the overlapping edges or projections a' , a' , which serve to properly locate the parts as the helix is wound up.

GOLD MINING OR PLACER MACHINE.

No. 663,717. C. BARWICK, DENVER, COLO. *Patented Dec. 11, 1900.* The device covered by this patent consists of a pan having an inclined bottom A^1 , one end piece A^2 and inclined sides A^3 . The end A^1 is

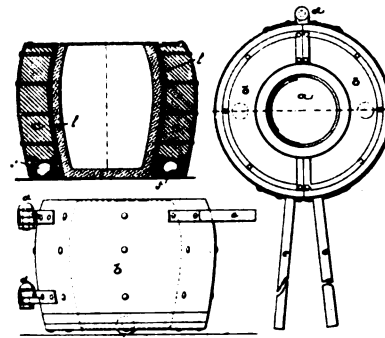


omitted and the pan is set on such an angle that water would stand as indicated by the dotted line X . The bottom of the pan is fitted with a central longitudinal groove A^4 and a series of transverse grooves A^5 , these grooves being shallower than the longitudinal groove. Near the deeper end of the pan there is also a deep transverse groove, and at the upper end of the pan there is a pocket A^6 for receiving the gold. The pan is mounted upon a carriage B which runs upon tracks B^1 supported by any suitable frame B^2 . The deeper end of the pan may be made to rest directly upon the frame while the open end of the pan is supported above the frame upon the springs B^3 which rest against lugs on the side of the pan A^2 . The height of this end of the pan is adjusted by means of the thumb nuts D which are screwed upon

the bolts D^1 . The pan is given a transverse shaking motion by means of any suitable device, as for instance the eccentric F^2 and connecting rod F^3 , which may be driven by gearing F^4 and a belt pulley F^5 . The eccentric takes hold of the frame by means of the rocking arm F and suitable joints as shown. Stop pins E are placed in the frame B to prevent the pan from moving in relation to the frame, and these stop pins bear against the pieces E' which are fastened to the slanting sides of the pan. Water is fed to the pan through the launder H . This water operates the paddle wheel H^2 which drives the revolving screen H^3 by means of a belt as shown. The material to be operated upon is introduced into the screen, where it is washed by means of a current of water from the pipe H^4 and the finer portions pass through the screen onto the apron H^5 , which conducts the material to the upper end of the pan while the coarser stones are discharged from the end of the screen.

CRUCIBLE SHAKER.

No. 663,676. J. ILLINGWORTH, NEWARK, N. J. *Patented Dec. 11, 1900.* This device is for holding a hot crucible, used in making cast



steel, while a charge is being placed in it; it also allows of the crucible to be shaken so as to cause its charge to settle. It consists of two semi-circular pieces b , b , hinged together at d . The crucible is shown at a . The pieces are held together by handles e , and by separating these handles the crucible can easily be removed. The device consists of a sheet iron body holding an asbestos filling c , this filling being protected from the crucible by a metal lining l . The pieces b are carried upon ball castings f so as to facilitate the moving of the crucible shaker from one place to another. During the shaking the handles e are moved up and down so as to bump the edges of the crucible on the floor, the castors f acting as a fulcrum.

PATENTS ISSUED DURING DECEMBER AND NOT ILLUSTRATED.

- No. 662,923. Gas-producer, E. J. Duff, Liverpool, Eng.
- No. 663,177. Twyer for blast furnaces, G. B. Klink, Tacoma, Wash.
- No. 663,205. Twyer, J. E. Willis, L. Boyd and J. Hill, Pueblo, Colo.
- No. 663,296. Gold-pan, D. B. Newkirk, Detroit, Mich.
- No. 663,304. Magnetic-separator, F. Theilengerdes, Memphis, Tenn.
- No. 663,375. Machine for extracting gold, G. Webster, Parramatta, N. S. W.
- No. 663,316. Awning for mine shafts or tunnels, B. B. Wheeler, Apex, Colo.
- No. 663,422. Hopper-delivery mechanism, E. S. Decker, Malden, Mass.
- No. 663,568. Process of working peat and manufacturing same into briquets, L. Galecki, Warsaw, Russia.
- No. 663,638. Coke-oven, H. Poetter, Dortmund, Germany.
- No. 663,651. Apparatus for elevating and handling coal, A. M. Acklin and W. J. Patterson, Pittsburg, Pa.
- No. 663,760. Magnetic ore-separator, A. Johnson, Moline, Ill.
- No. 663,764. Magnetic Separator, E. Kreuser and H. E. Langguth, Mechnich, Germany.
- No. 663,914. Art or process of treating ores, H. Luckenbach, Seattle, Wash.
- No. 663,945. Ladle for molten metal, J. A. Waldburger, and W. J. Smith, McKeesport, Pa.
- No. 663,946. Power apparatus for removing skull from ladles, J. A. Waldburger and W. J. Smith, McKeesport, Pa.
- No. 663,993. Gold-separator, W. W. M. Hickey, San Francisco, Cal.
- No. 664,017. Process of Manufacturing Coke, A. M. Edwards, Newark, N. J.
- No. 664,059. Ore-mixing machine, J. P. Schuch, Jr., Cripple Creek, Colo.
- No. 664,066. Prospecting-pan, J. Tobin, New York, N. Y.
- No. 664,073. Hoisting Machinery, H. C. Behr, San Francisco, Cal.
- No. 664,153. Ore-roasting furnace, F. W. Holtman, Richmond, Va.
- No. 664,230. Air-compressor, H. M. Salyer, New York, N. Y.
- No. 664,330. Amalgam-press, A. Mackay, Douglas Island, Alaska.
- No. 664,427. Conveying apparatus, S. B. Peck, Chicago, Ill.
- No. 664,488. Bath for rendering ore friable, K. Miller, London, Eng.
- No. 664,502. Drill tripod, P. H. Reardon, San Francisco, Cal.
- No. 664,562. Unloading means for air compressors, G. DeLaval, Cambridge, and G. P. Aborn, Boston, Mass.
- No. 664,563. Unloading means for air compressors, G. DeLaval, Cambridge, and G. P. Aborn, Boston, Mass.
- No. 664,626. Machine for collecting precious metals from river beds, J. R. Dake, Merrill, Wis.
- No. 664,635. Ore-separator, A. C. Hartung, Galena, Kan.
- No. 664,650. Electromagnetic ore-separator, E. Kreuser, Mechnich, Germany.
- No. 664,712. Grading-amalgamator, A. Z. Baldenebro, Mexico, Mex.
- No. 664,768. Ore-separator, A. R. MacDonald, Jr., Montreal, Can.

Mines *and* Minerals

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CHLORINATION MILLS

At Cripple Creek, Colorado—The Methods Used in Handling the Ore and the Application of the Process.

Written for MINES AND MINERALS by Prof. Arthur Lakes.

In the early days of Cripple Creek ore was packed on the backs of prospectors to Colorado Springs and Florissant, and forwarded thence to Denver or Pueblo for smelting. Very soon, however, stamp mills of the Gilpin County type were put up on the ground and in 1893 at least 270 stamps were at work. Frue vanners, bumping tables and blankets were successively added to the batteries, but even then only 50% of the assay value was obtained and large amount of good ore was wasted.

At an early date in Cripple Creek history it was found that the ordinary stamp and concentrating mill was not a success in treating Cripple Creek ores, and recovering full values, especially when the mines had reached the sulphide zone in depth and in 1897 only fifty of the stamps mentioned above were working.

Other processes became necessary for treating the ore on the ground, and cyanide and chlorination have been successfully tried; both have their merits, and each holds the ground well against its rival.

In 1893 Mr. Edward Holden converted a stamp mill at Lawrence, two miles from Cripple Creek into a chlorination mill, as the result of experiments made upon the treatment of telluride ores, by Mr. W. S. Morse of the Russell lixiviation works at Aspen. Barrel chlorination was used similar to the South Carolina and Dakota practice.

There were two small cyanide mills established at Cripple Creek with a small chlorination department attached to one of them. Owing to conveniences for water, coal and

transportation, the larger cyanide and chlorination works were established at Florence about 25 miles distant. The great Argall cyanide works are well known at Cyanide near Florence. The Davis chlorination works have also for some time held their reputation, and now another large cyanide mill is being erected on the banks of the Arkansas, and one of the largest chlorination mills in the country is also in progress of erection near the same spot. The Woods Investment Company has also erected a very large chlorination mill near Victor in connection with their mines at Cripple Creek, known as the Economic Gold Extraction Co.

The chlorination practice in the Cripple Creek district is the typical barrel process, the changes during recent years having been mainly in the direction of increased capacity and better mechanical arrangements.

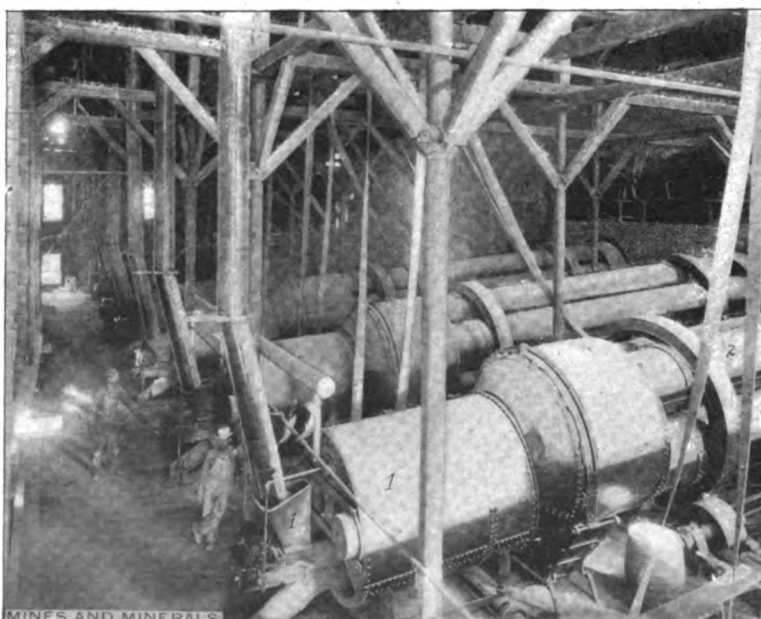
The Economic Gold Extraction Company's chlorination mill is situated on the steep north slope or face of Squaw Mountain in Arequa Gulch a few miles south of the city of Cripple Creek.

In this district, so hilly is the region, that the old system of making a deep excavation for placing a mill of this kind on the

steep slope of a hill or mountain just above the stream has to be followed, instead of locating all the buildings on the flat, as is done preferably at the Argall cyanide mill and the new Milliken chlorination mill at Florence.

There each department devoted to a particular process in the successive stages of treatment of the ore is in a separate building, on the flat ground, which system is said to have its advantages over that of combining them all in one building on different floors, one below the other, on the steep excavated slope of a mountain.

The Economic mill is an imposing structure as we approach it coming up Arequa Gulch. Its huge mass of drab-colored buildings rising tier upon tier from the bottom of the gulch to high up the hillside, from a distance seems to fill the whole vista of the



ARGALL TUBULAR ROASTING FURNACE—1, AUTOMATIC STOKER, 2, 2, TUBES OR CYLINDERS.

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gulch between the fir-clad granite walls. Beyond the tall buildings the crowded mines of Bull Hill are seen on the hillsides which everywhere are freckled with prospect holes in a most wonderful manner, as if the hills had broken out in a sort of geological small pox. No mining region that we have ever seen is so pitted with holes and prospect trenches as that of Cripple Creek.

The height of the entire mill edifice from top to bottom is 150 ft. The longitudinal dimensions of the buildings are 130 ft. long by 128 ft. wide.

There are six stories in the mill; the outside is sheathed with metal plates, coated with elaterite and painted a drab yellow color.

Above the highest story of the building are three railroad tracks rising in terraces one above the other, and cut into the side of the mountain. All railroad switches are owned by the mill. These lines discharge ore received from the different mines direct from the cars into chutes and bins.

At the top building we look down into the wide open mouths of three of these feeder bins ready to receive the ore which descends from them to the third floor. The ore after passing through the feed bins goes direct through a large Gates crusher. The material reduced to about the size of a walnut then passes through two small jaw crushers on the floor below. Thence the reduced matter is elevated by plain rubber belt conveyors to the second floor where it passes through two rolls and from the southwest wing of the building, it goes direct into the roasters.

The rolls are composed of soft iron cores with a center pivot going through them, the outer rim being surrounded by hard steel.

These sample rolls are eighteen inches in diameter. They are fed from above by an apron and after grinding, discharge the material by another apron on to the belt conveyor. To assist in comminuting the ore and to prevent the rolls becoming too smooth by constant uniform friction, the rate of speed of one roll is slightly faster than the other; crushed material drops into bins under the belt conveyor.

The advantage of the smooth broad rubber belt conveyor over conveyors of a different pattern is that it avoids friction and excessive noise as it passes smoothly over rolls and over a chainwheel where it can be seen dumping its material, like a dirty waterfall.

The Gates crusher receives ore from the R. R. bins and crushes it, then two crushers receive the product from the Gates crusher above and still further comminute it. The principle of the crushers is a stationary jaw opposed to a movable jaw of steel moving on a pivot; between these the ore falls.

Besides these crushers there are six other 16" x 36" Denver Engineering Co. rolls crushing to 16 mesh. The spreading movement caused by a large stone dropping between these rolls is obviated by strong spiral springs on either side of the rolls, pressing against them and keeping them in place. An ingenious device also transfers this spreading tendency of movement from a lateral thrust to a perpendicular motion.

The whole machinery of the mill is run by electric power, and on our descent through the building we pass a room containing six switch boards for as many different motors. This completes the general description of the upper part of the building devoted entirely to crushing. In the second or lower half of the building the roasting and chlorination is carried on.

Interferences in chlorination are caused by the presence of lime, sulphur and tellurium. Sulphur must be under two-tenths of one per cent.; lime under one per cent.; and telluride ores must be quite oxidized before they can be chlorinated.

The Cripple Creek ores are mainly composed of telluride gold-bearing minerals, or gold-bearing pyrite, and some oxidized free

gold in a gangue of quartz, often stained with fluorine, in a country rock of either phonolite, andesite, or decomposed granite. The ore as it comes from the mines is so wet that it has to be roasted or dried, preliminary to other operations, in a long cylindrical roaster, tapering at one end; this roaster is 30 ft. long, 4 ft. diameter at the larger end and 30 inches at the smaller.

There are seven roasters of the Argall pattern, containing four cylinders, each with diameter of three feet, length 36 to 38 feet lined with fire brick, using automatic stokers, coal feed and air blast. The stoker is in a cylinder of 6 feet in diameter. The ore is fed to the roasters by cars; the cylinders rest on trunnions and have a slant of six inches in six feet. The capacity of these roasters running on average low-grade Cripple Creek ores is 40 tons per day. The rotation movement is very slow. The time required for a complete roast of ores, carrying less than one per cent. sulphur, is 2½ hours. These roasters have two speeds; one of 2½ hours, and another of three and a half hours, regulated by the speed of rotating.

After roasting, the ore is discharged into coolers below which are large cylinders five feet in diameter revolving in water jackets.

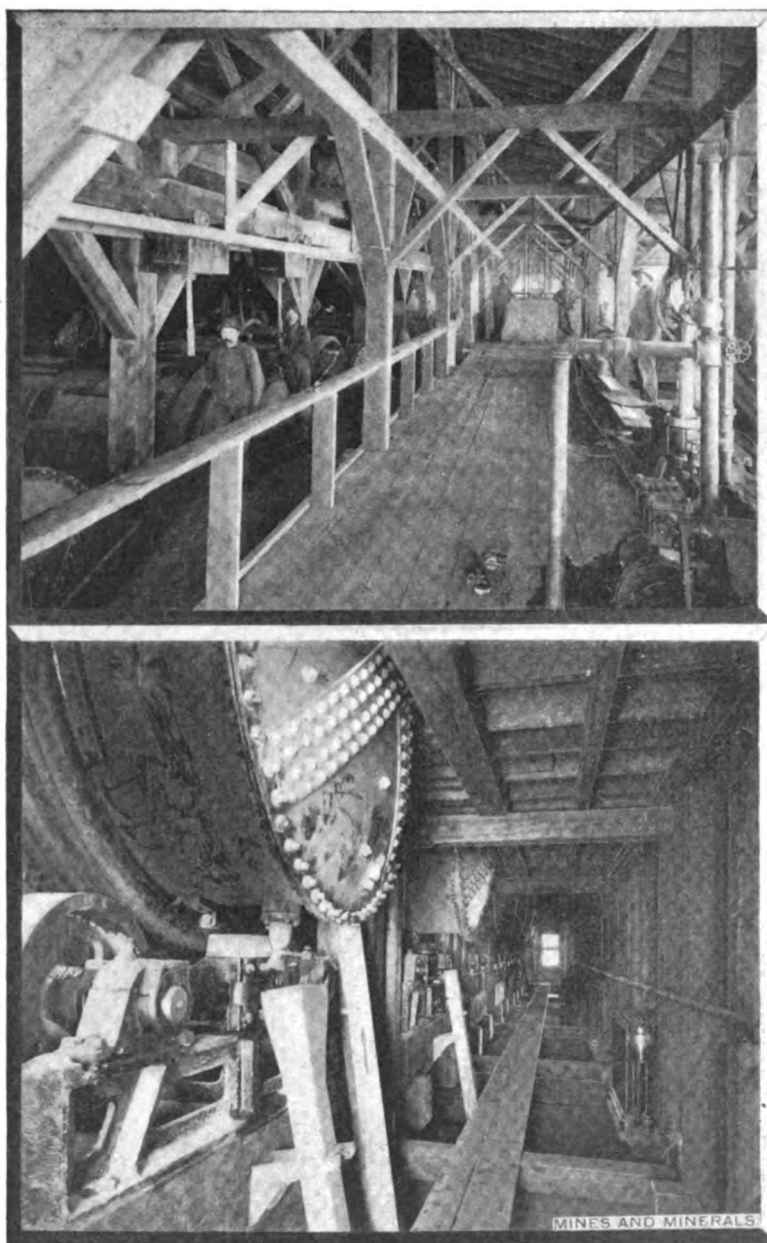
After the ore is cooled it is elevated to pulp bins and there measured out into scale hoppers. After being weighed it is discharged through other hoppers, and thence into chlorination barrels below.

These barrels of which there are seven, are 7 feet diameter, and 17 feet in length and are larger than

those used in most mills; having each a capacity of 20 tons of ore, 18 tons being the average charge. The barrels are of riveted steel plates and are lined on the inside with lead which is not affected by the acids used.

With the charge of roasted and comminuted ore, bleaching powder (chloride of lime) is mixed. When the barrels are charged they put in a certain amount of sulphuric acid, then the barrels are closed and rolled for four hours. They are then washed out the solution passing through a filter in the barrel. The filtrates are run into solution tanks below and the tailings run on to Wilfley concentrators.

The general principles of the chemical process are as follows:



CHLORINATION BARRELS, ECONOMIC MILL.

Sulphuric acid acting on bleaching powder liberates chlorine gas, which is a solvent for gold, the gold becoming a gold chloride.

To precipitate the gold as gold sulphide, sulphureted hydrogen gas H_2S , is passed through it which brings the gold down as black precipitates. This is filtered out and the precipitates roasted to get rid of excess of sulphur. The roasted product is fluxed and melted and cast into gold bars.

Below the great revolving barrels are storage tanks; large square tanks in three tiers; through these is passed the H_2S gas.

The concentrators are in the lowest section of the building and receive the tailings from the chlorination barrels which still contain some values. These residual tailings are passed over 10 Wilfley tables (double deckers) and two finishing tables.

Solutions that have been precipitated come in through separate sections, and are forced through the filter press; any precipitate of gold sulphide is then caught on the filter papers and flannels of the filter presses. There are three presses; each press four feet long; the pressure is by a screw turned by hand; there are 21 sheets of flannel between metal partitions.

The gold sulphide is taken out of the filter presses and put in pans, then in muffles and allowed to roast at low heat till the excess of sulphur is burned off. The muffles are three feet wide by one foot high and four and a half feet long. After roasting the sulphide is mixed with a flux and put in graphite crucibles. These are heated in a furnace by an oil fire.

The day after our first going through the mill we were invited to see the periodical melting and refining of the ore in the refining room. This refining room is 50 feet long by 20 feet wide. It is principally occupied by a large assay furnace, a weighing machine, a revolving pulverizing barrel, and the melting or refining furnaces.

The assay furnace is seven feet high by six feet wide containing ten large muffles in two rows. On top of the assay furnace are rows of large graphite crucibles for use in the smelting furnace; six shallow metal trays for receiving the sulphide and carrying it to the smelting furnace, stand ready for use, leaning against the walls. These are 3 ft. wide, 4 ft. long and 4 inches deep. A furnace chimney stands between the assay furnace and the crucible smelting furnace united to both.

There are three crucible smelting furnaces 5 ft. by 8 ft. by 3 ft. high, of fire brick, which present a blazing appearance as we enter the room, the flames from burning oil roaring up on either side of metal trays lined with fire brick which cover the top orifices of the furnace. These trays, or covers are 3 feet by 4 feet, and run on wheels on railroad irons across the top of the furnace, whose fires they cover.

The sulphide ore is taken out of the filter presses in the filter room, and placed in metal pans or trays, and laid in the muffles of the assay furnace and roasted, the fuel used being residuum oil blown by steam. The ore is then pulverized in a revolving barrel containing steel balls; flux and sulphide ore, borax glass, soda, lime and silica, are all mingled together in the pulverizer in proportions determined by careful weighing. The well-mixed material is then fused in the big graphite crucibles of the crucible furnace; the result comes out in cakes and is loosely broken up. The sulphide averages 55 per cent. gold; the proportion of flux is two-thirds flux to one-third sulphide. The trays containing the sulphide that has passed through the muffles are drawn from the muffles and laid, full of reddish oxidised material, about the size of walnuts close to the crucible furnace. The graphite crucibles are filled with this and two at a time are placed



THE ECONOMIC CHLORINATION MILL, AREQUA GULCH.

in each of the blazing furnaces till the sulphide is thoroughly melted. It is then taken out and poured into pots. Bullion buttons are melted and run into bricks. The arm of a crane affixed to the wall of the room is moved round and assists in picking up the crucible and placing it inside the furnace.

Slag is melted over again with litharge forming lead bullion.

The main divisions of the melted product are bullion, iron sulphide and slag.

The graphite crucibles of which there are two to each furnace are No. 100 Dixon, 14 to 16 inches high, 10 inches across.

The gold is finally shipped to the Mint as 900 to 945 fine.

The water supply of the mill comes mainly from the workings of the adjacent Gold Coin Mine, from which it arrives at the mill through a long tunnel driven through Squaw Mountain. To economize the water which is proverbially scarce in Cripple Creek a simply contrived water tower is erected, which cools the water before it is used over again. The tower is made of layers of boards a few inches apart like a lumber pile. Through these the water trickles and is cooled by a draft passing between the different layers of lumber.

FLORENCE, COLORADO, MILLS.

Florence is a centre for the liquid chemical treatment of ores, as Pueblo is for the fire process. It is also a natural and convenient point for treatment, especially of Cripple Creek ores, it being the nearest point to that camp having an abundant supply of water, coal, oil, also railroad transportation, hence we have there the Argall cyanide mill; the Durcas Company cyanide mill in process of construction; the Union or Milliken chlorination mill also in process of construction and the Davis chlorination works. At the latter the ore on arriving at the works passes through a grizzly onto a set of Rogers rolls, of which there are both coarse and fine. The first set crushes to about the size of a walnut, the second to that of fine gravel. This material then goes to the drier, which is simply a single, hollow cylinder, divided lengthwise into partitions; the furnace is fed by oil and blown by steam. There are two revolving driers of large capacity. Thence the material passes to another building containing the roasting furnaces. Here are two Pearce Turrets with water jacketed arms, of 60 tons capacity. From the turret roasters the ore passes to the eight revolving barrels, containing five tons each and lined with lead with a filter on a cane-like frame below. The liquor filters through this and leaves the sand behind.

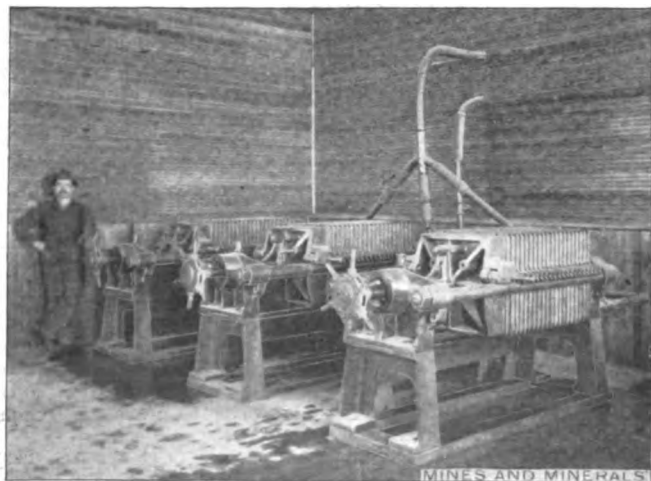
Below this floor is that on which is the filter of charcoal. The liquor containing chloride of gold goes through this charcoal filter and leaves on it a precipitate and passes out clear.

The chemical action set up is the formation of hydrochloric acid, resulting from contact of chlorine with the charcoal, setting free the gold which is precipitated on the charcoal.

This charcoal charged with precipitates and coated with brown gold is then simply burnt to ashes in larger open pans, and the gold is thus freed.

The tellurides and siliceous ores of Cripple Creek are the favorites for this kind of treatment.

The Union Gold Extraction or Milliken mill is a very large chlorination mill in process of construction on the north bank of the Arkansas River at Florence. The buildings of the different departments are on the flat ground. The works are to be run by electric power. Six Pearce Turrets are in construction for roasting the ore, with one cooler to each set of two turrets, in which the hot ore from the turrets is slowly cooled by rabbles turning over the material, and exposing it to the air, and by the further use of a fan. The chlorination barrels are of the largest make, and all when complete will be on the largest and newest style.



FILTER PRESSES, ECONOMIC MILL.

THE WINDBER MINE.

A Description of the System of Underground Haulage and Mining Methods as Installed and Used.

By J. S. Cunningham, M. E.*

GENTLEMEN:—I have been requested by your Secretary to describe the system of underground haulage and mining methods as installed at Windber.

It affords me pleasure to do this though we have nothing there unusual or that merits extended notice.

Windber, as you are aware, lies along the Somerset-Cambria County line and is the center of a new development in the lower productive coal measures on the Wilmore Basin synclinal. The valley made by Big Paint Creek which creek forms the boundary line between the counties for the last two miles of its course before emptying into Stony Creek, has been cut into the lower productive measures so deep that mining operations can be advantageously located above water level over a large area of territory. This is the reason for Windber's existence.

The operations at present are confined to the "B" or lower Kittanning Vein, locally known as the Miller Vein, and this dips gently to the northwest towards Johnstown, causing two of the eight operations to be slopes—the other six being drift mines; all grouped within a radius of 2½ miles from Windber as a center.

The tendency of bituminous mining at the present day is towards greater economy in production by the introduction of machinery for cutting and hauling coal, wherever the situation is favorable for its adoption. This is also the tendency in all branches of industrial enterprise and its ultimate result is alike beneficial to both capital and labor.

Such was the case in the Windber region when we began operations in 1897. After due consideration it was decided to install electrical haulage, and compressed air coal cutters of the puncher type.

It is true we have been criticized for not using electricity throughout; but each region and vein of coal must be considered on its merits, and the coal cutting installation for a hard thick vein such as exists on the Panhandle, would not necessarily be the one suitable for a soft thin vein.

At any rate, after a careful trial with electrical coal cutting machines, we found it impracticable with a thin vein 3 ft. 6 in. to 4 ft. thick, troubled with an uneven bottom, to operate advantageously otherwise than as we are now doing and produce a large output. At present we have eight operations, numbered 30 to 37 inclusive; and 38 to 40 inclusive are being opened. Nos 30 to 35 inclusive have about reached their daily capacity. Nos. 36 and 37 are new mines with a daily output of one-third final capacity. Six of these are drift mines, with coal lying from level to 5% grade in favor of load. The other two are slopes with from 1 to 4% grade against load.

The subject of this paper being underground methods, the only reference I will make to the outside arrangement is in connection with haulage. We have six haulage plants for the eight operations, and these are so connected that in case any plant breaks down, the operation to which it principally furnishes power can be taken care of by the balance.

* A paper read before the Western Pennsylvania Central Mining Institute, Dec. 20, 1900, Pittsburg, Pa.

There is nothing new in our haulage or mining methods that we are aware of, except possibly that we drive all headings on straight lines, of ample width for the traffic to be handled and equip them with well surfaced roads to handle coal quickly from face of room to tipple. There are no doors in any mine.

The general plan of working is that of room and pillar, though we believe longwall retreating could also be advantageously employed, if the time to drive necessary headings could be spared.

Each mine has one main heading, two main airways—one on each side of main heading called right and left airways, and right and left side headings opening off alternately from the main headings. The airways to these open off the right and left main airways which cross the side headings by overcasts (as shown on plan). The main airway from the fan splits and crosses the main heading by an overcast, forming the two main airways. The fans used are all of Capell pattern but of different sizes to suit the mine where installed. The first one installed at No. 30 mine can be used for either force or exhaust; but it has never been used except as a pressure fan. The largest fans of the balance are 6 ft. $\times$ 16 ft. and they all work pressure.

The main heading is 16 ft. wide and 5 ft. 6 in. above rail. The main airways are driven in coal only, and wide enough to make 50 sq. ft. sectional area each.

The side headings are driven narrow for 90 feet from main heading to strengthen pillar, then 16 to 18 ft. wide—8 to 10 ft. of which are used to gob the bottom or top taken from the eight feet in width that is to make five ft. high over rail.

Distance center to center of main airways is 80 feet, with 80 ft. of pillar between each and the first room off either right or left headings. These rooms are turned off 60 feet center to center and driven 30 to 35 feet wide; as the top is extra good, this condition of roof is usually the case leaving pillar of 30 to 25 feet. When the top is bad, the room is narrowed in and the pillar thickened.

There are two tracks of 30-lb. rail in main heading 3-ft. gauge 4 feet apart; one is used as a loaded, and the other as an empty track. There is a cross-over track for each side entry between the two main heading tracks, the point of switch being at least 30 feet from point of switch of side entry to prevent mine wagons locking bumpers. It is important to have these tracks well graded, aligned, ballasted and drained to secure anything like good haulage results. Side headings are laid with 30-lb. rail and each room with 8-lb. rail on 3 inch ties.

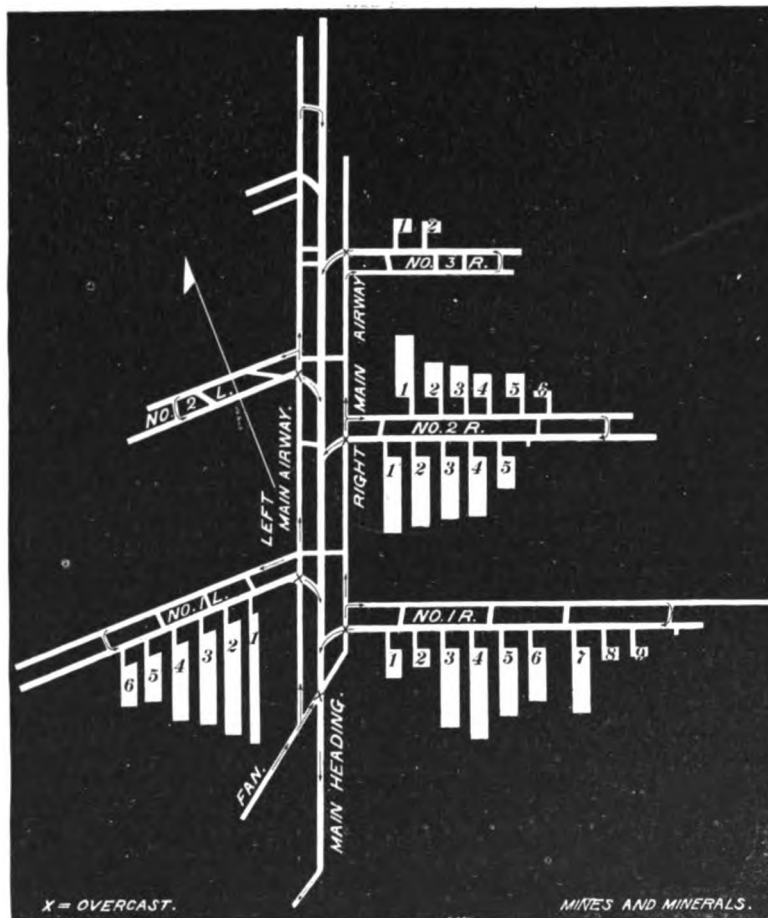
One track runs straight from entry to face of room; the center being 5 feet from right hand rib. This is the sight or guide track. After a 30-ft. narrow neck is turned, a track is turned off to the left and runs along the left-hand rib, making two tracks in each room. The gob is thrown in center.

Rooms are driven 300 feet and a 30 ft. pillar left between the face and the next back entry. Pillars are drawn when rooms are finished and the roof allowed to settle.

Punching machines of No. 700 type are used; each cutter and scraper taking care of four to six rooms. Two loaders, if good men, can handle a cut across face of their room in one shift; sometimes they take a third man or a boy. Rooms are kept propped up eight to nine feet back from face.

The cut is about 1 ft. 6 in. high at face, and 4½ to 5 feet deep. Generally two or three shots bring the whole face down.

Air lines of 6 in. and 8 in. wrought iron pipe run along the



PLAN OF WINDBER MINE.

MINES AND MINERALS.

main airways, 2 in. and 4 in. in side airways, 1½ in. in rooms, with hose connections to machines in usual manner. Pressure is maintained at about 65 lbs. for cutting and pumping.

The mine wagons are small compared to those in the Pittsburg region where the coal is thicker—being nine feet in length end to end of bumpers, and three feet high from rail over front end gate. They hold one ton five cwt. gross, and weigh about 1,150 lbs. Hitchings are of best quality soft wrought iron, hand welded.

A mine producing 75 to 80 railroad cars or 1,800 to 1,900 gross tons daily, requires six locomotives—one at night (because we run our principal headings night and day) and five in daytime. One of these is a spare locomotive, one of the five frequently being used at night. It is false economy to keep these locomotives waiting for wagons; hence, we have for a mine such as above, about 600 mine wagons, and from 25 to 30 mining machines; some of which, however, are assigned to contractors driving headings, who do not keep them constantly at work. Two air rock drills are also used at each mine.

The average locomotive's efficiency is about 300 gross tons daily. Some may haul 250 tons where others do 350 owing to variation in grades and local troubles. The number of wagons hauled depends upon the grade, if any, against the load, and averages 30 to 40 wagons per trip.

The method of gathering coal is to divide the entry into sections. An entry of 27 rooms would have three, nine-room sections.

A motorman with a 36 empty wagon trip, would run slowly along while his spragger cut off four cars for each room; this is done without stopping. Then they couple to the four loaded cars from each room of the next section and run out; in each case the locomotive being ahead of trip.

It is of the greatest importance to keep locomotive tracks in first-class condition. Frequently in mines installing electrical haulage, poor results are obtained because roads are not kept straight, and curves are made too sharp.

The Windber Mines have no curve on their locomotive haulage tracks less than 54 feet radius, and use a No. 3 frog which gives 18 feet from point of frog to point of switch on crossovers and turnouts. All curves are elevated on outer rail to suit a speed of 6 to 8 miles per hour. As a consequence, when a trip is started at this speed, there is no reason why it should lose any speed or coal until it reaches the tippie. The room partings are No. 1½ frogs with 9 feet from point of switch or latch to frog, radius being 13½ feet. This is for mine wagons. No other size of frogs or lengths of leads are used in any mine on turnouts from straight tracks, which simplifies the furnishing of material. Easy curves admit the use of locomotives of 54 in. to 56 in. wheel base and enables us to get a better electrically designed locomotive than if the manufacturer were confined to 48" on account of sharp curves in track.

The locomotives used are of the General Electric and Baldwin-Westinghouse types—12 and 14 tons. The earlier locomotives installed in 1897 and '98 were 12-ton with 3,500 pounds drawbar pull, 8 miles per hour. The latest are 14-ton 5,000 pounds drawbar pull, six miles per hour. These latter are powerful machines and can haul 50 mine wagons up a 3 per cent. grade. In fact, we find the wear and tear on locomotives less when pulling up grade than when grade is in favor of load. The temptation in latter case is for motormen to reverse current and not use brake enough; holding trip back thus damaging locomotive.

Double 0 wire is used and hung up 12 inches outside of the outer rail on double track and at various distances on curves. The wire is hung to the roof in the usual way with hangers 40 feet apart or closer when necessary. The heading contractors bore holes in roof for these hangers 1½ in. × 7 in. as headings advance and a wire man puts up the line when necessary; being protected by means of a sectional insulator from damage so that locomotives may work up close to him when hanging wire. He takes the sectional connector out and carries it with him until work is completed. Sectional insulators are placed about every 2,000 ft. on main headings and operated by the standard sectional switch box; and we place them on all side headings about 20 feet in off main heading.

This arrangement of insulators, allows us when short circuit occurs, to cut out each side entry and clear the main heading for traffic; also to locate the point where trouble has occurred.

At each crossover on main heading, we have five 110 c. p. lamps; and at curve at main heading to side heading, two 275 c. p. lamps, our current being 550 volts.

Rules are provided for the prevention of collisions similar to those in use on a surface road and a mine is divided into sections so that each motorman has his own section which makes little delay gathering coal.

The system in use admits of any combination of cutter, scraper and loader receiving proper credit for coal mined.

We contemplate using a 40 to 45 lb. rail in main headings

hereafter, to reduce the wear on locomotive wheels which is now excessive. There are also other advantages which will readily suggest themselves.

The whole aim in the Windber installation is to keep every active piece of machinery necessary for the production of coal busy at effective work, and replace it instantly when broken or damaged.

Doubtless inside of 5 to 10 years the electrical machinery we now have will be found on the scrap heap, and something more up-to-date will replace it. We will come to compound condensing duplex compressors, and new mining methods may be installed from which we can all learn something. We can only say at present, we are in a state of evolution, and what exists to-day, may be discarded to-morrow for something better.

THE CERRILLOS ANTHRACITE MINES.

A New Mexican Coal Mine Which Interestingly Illustrates the Metamorphosis of Bituminous into Anthracite.

Written for MINES AND MINERALS by Prof. Arthur Lakes.

We have, or are supposed to have, so little anthracite coal in the West that a veritable anthracite coal mine is a novelty of especial interest. Such we heard of being near Cerrillos Station in New Mexico and in a recent visit to that country we stopped off to examine it. We were surprised to find not only a well and deeply developed mine, but a coal village around the works of many substantial houses and numbering some 500 to 800 inhabitants, with an extensive plant and a large coal breaker of thoroughly eastern or Pennsylvania pattern.

The Cerrillos Mountains are a small group of hills some 50 miles north of Albuquerque City, New Mexico. They are formed of a central core of eruptive porphyritic rock surrounded by a series of uptilted sandstones of the Laramie Cretaceous coal bearing series. Into these strata many dikes and intrusive sheets of porphyrite have been intruded, emanating from the parent core. The heat from these eruptive sheets, when they have come near enough to the coal, has metamorphosed the coal into anthracite. Coal beds not so influenced in the same region remain unchanged as bituminous coal, consequently there are two classes of coal worked near one another. One a four foot six inches seam of bituminous coal and another, some 50 to 75 feet below, of three feet six inches to four feet of anthracite overlain by a thick intrusive sheet of eruptive porphyrites.

Before visiting the mine we examined the plant.

In the engine room was a Corliss engine of 240 H. P. with a 16 ft. diameter fly wheel. This engine was for haulage up the slope of the bituminous mine. The ventilating exhaust fans for the bituminous mine were in an adjoining building. At the anthracite mine a Murphy 9 foot fan is used. A duplicate of the haulage engine is used at the anthracite mine.

The bituminous mine is opened by an incline shaft sloping twelve degrees into the hill; the haulage is by a tail rope system. Mules haul the coal from the side entries to the main slope, then the tail rope takes it up to the outside and the coal is dropped down to the tippie by gravity and by a switchback. The grade is 5 per cent. for 150 ft., and 3 per cent. for the rest.

In the anthracite mine whose opening is some distance from the bituminous mine the inclined shaft is 2,700 ft. long. The shaft enters the coal seam around a curve, the sides of the curve being protected by a steel fender. The inclination of the incline shaft follows that of the coal seam from 13 to 16 degrees. Near the bottom of the mine the seam is nearly flat. Towards the lower 800 ft. of the mine the coal, though anthracitic is not so firm and hard as in the upper portion.

There are seven levels driven from the main incline mostly on the West Side. Near the bottom is a fold or fault which temporarily crushes out the coal for some few feet. The anthracite seam is 3 ft. 6 inches, to 4 ft. thick; the roof is of sandstone. The side drifts are driven at right angles to the main incline. From these the rooms branch off with pillars 18 to 20 ft. thick between them. The side drifts or levels are 200 ft. apart.

The mode of haulage in the side entries is by having a wide double track station, or landing near the main incline. Onto this mule teams draw and land the coal cars from the rooms and side entries and then the cars are taken in tow by the main tail rope system.

In several of the levels there is a stationary Lidgerwood engine which hauls the cars from both up and down the side level, and switches them on to the main side entry, where the mules haul them to the main incline and to the main tail rope system.

The cars are pushed by hand from the rooms on to the incline worked by the Lidgerwood hoist. There are five of these Lidgerwood engines in use in the different side levels.

For drilling for blasting, Hardeocg hand drills are used with three bits, one 6 ft., one 4 ft. and one 2 ft. long. Black powder is used and no picking is done, the coal being too hard. About 200 tons is the daily output. Signals are by electric bell and telephone. The stationary engines are run by compressed air. There is scarcely any gas in the mine. Some of the side drifts are over 2,000 feet in length. Timber has to be used more or less throughout the mine. There is a little water in the mine, which is easily controlled by five Dean pumps.

The coal shows a "butt" and "face" cleavage, but no partings or other impurities. There is a large coal breaker below the mine which is of the usual Pennsylvanian type. The coal is broken to the usual size by this.

Climbing the hill above the mine we find ourselves on a country sloping gently eastward. This country is underlaid by a wide and thick intrusive sheet of eruptive porphyrite lava. In some places this lava appears to be above the coal, in others under it at a common distance from the coal of about 25 ft. The lowest part of this sloping hill is some 300 ft. above the coal worked in the mine slope, but shows distinct outcrops of the lava.

The lava is supposed to have come up from a dike and sent out an intrusive sheet between the bituminous seam above, and the now anthracitic seam below, and by its heat influences to have metamorphosed the coal to which it approached nearest into anthracite.

The bituminous seam proper is upwards of 50 to 75 ft. above the anthracite seam; the bituminous coal is unchanged when it is at a distance from the lava, but rapidly becomes anthracite as it approaches the once molten rock.

From the top of the hill we have a fine view of the surrounding country and can easily trace the outcrops of the lava sheets and dikes, and their relation to the coal seams.

In the distance about four miles to the south is the eruptive center of the Cerrillos hills in which are the turquoise mines, where all the strata involved in the uplift are much metamorphosed. To the east are the Santa Fe Mountains with the old

British Columbia Boundary District.

Up to December 1 there had been smelted at the Granby Company's smelter at Grand Forks, about 48,000 tons of ore. The first furnace was blown in on August 21 and the second on October 13, 1900. Each furnace has been in continuous operation ever since it was started. As the ordinary daily run is from 600 to 650 tons it is estimated that about 20,000 tons will be treated during December. This will make the aggregate for rather more than four months about 68,000 tons. Nearly all of this ore is from the Old Ironsides, Knob Hill and Victoria group of mines situate at Phoenix, about 17 miles from the smelter, mines and smelter being connected by the Canadian Pacific Railway Company's Columbia and Western Railway, which was built into the Boundary district in 1899. Shipments of ore from these mines to the smelter commenced on July 11. Until August 24 five 30-ton cars per day were shipped. From August 24 until October 16 ten cars per day were sent out. On October 17 shipments were increased to 20 cars daily and this output has since been regularly maintained. The latest announcement is that the ore trains, which have hitherto included only ten cars each, have been increased to eleven cars. Two trains are run daily, so that twenty-two 30-ton cars = 660 tons, are now sent out every day. Including an extra train run on one day in November, the tonnage from this group of mines to the end of December will stand about as follows:

	Tons.
For July.....	3,110
For August.....	5,850
For September.....	9,000
For October.....	13,800
For November.....	18,300
For December.....	19,500
Total.....	69,600

There have been received at the smelter from other mines smaller quantities, say 10,000 tons in all. The ore is reduced to a matte containing 50% of copper. Most of this matte goes to New



THE CERRILLOS ANTHRACITE COAL MINES, NEW MEXICO.

Spanish City of Santa Fe lying at their base. The country is much interrupted here and there by peaks and dikes of eruptive rocks.

Two borings were made by the company to discover the nature of the underlying strata and the presence, number and quality of coal seams. One was made near the White Ash, or bituminous mine about 4,200 feet ahead of its present slope. No. 2 was made 6,800 feet ahead of the mouth of the White Ash. In No. 1 230 feet of barren soapstone, red soapstone and sandstone were pierced before the lava sheet was encountered. Then lava (porphyrite) was found 425 feet thick; then ten small seams of coal. At 855 feet a seam of bituminous coal four feet thick was struck with 2 feet of fire clay. The depth of this drill hole was 861 feet. No. 2 drill hole was put down 680 feet ahead of the White Ash slope till it reached the lava at a depth of 104 feet. The lava was here found to be 497 feet thick; below it was red soapstone, sandstone, and slate, followed by seven small seams of coal. At a depth of 690 feet, or 87 feet below the lava sheet, anthracite four feet in thickness was met. The total depth of this drill hole was 1,602 feet.

The anthracite from this mine which has been worked for several years has mostly been shipped to California and the western coast. Upwards of 200 men are employed in the mine.

Cyanidation vs. Chlorination.

The difference in cost after roasting has been performed between the cyanide and chlorination process lies in the amount and value of the chemicals used. The chemical cost in chlorination is said to vary from 50 to 70 cents per ton; in cyaniding from 25 to 45 cents per ton. While this would appear to indicate that chlorination would be dearer, other elements, such as coarser crushing for chlorination, and percentage of saving, offset this advantage. The ore itself should determine the process to be used.

York, to be refined in Eastern refineries, and the remainder to Swansea, Wales. The first matte was shipped on August 29. Between 1,700 and 1,800 tons of matte had been sent out by the middle of December. November was the first month during which both furnaces were in operation for a full month and during that period 18,050 tons of ore were smelted and 704 tons of matte shipped. Although the nominal treatment capacity of the furnaces is but 250 tons each, owing to the singularly favorable character of the ore, which is self-fluxing, as much as 764 tons of ore have been run through the two in 24 hours, this constituting the record run to date. The importance of this industry—which is as yet only in its infancy—to the Boundary district cannot readily be realized by those not familiar with it. Two more district smelters will be in operation early in the new year, plant and machinery for both having been received at Greenwood and are now being installed.

Besides the group above mentioned there are two other producing mines in the district. These are the B. C., owned by the B. C. Chartered Company of Montreal, Quebec, and the Mother Lode, owned by the British Columbia Copper Company of New York. The B. C. has sent to the Canadian Pacific Company's smelter at Trail more than 16,000 tons of ore to date, and the Mother Lode, which is now being equipped with the largest power plant yet sent into the Boundary district, is preparing for an early output of at least 300 tons per day. The British Columbia Copper Company also owns the smelter now being completed at Greenwood. This company recently had an experience that is unique so far as mining companies operating in British Columbia are concerned in that its \$5 shares sold freely on the New York and Boston Stock Exchanges up to \$20.50 and this before any cash returns have been received from mine or smelter. Within six months there will probably be several other mines that will be entitled to rank as producers, but at present they are not in a position to maintain an appreciably large daily output of ore.

E. JACOB.

SAVING SLIMES.

Experiments in the Recovery of Values Which Have Gone to Waste in Tailings From Concentrators of Lead-Silver Ores.

Written for MINES AND MINERALS, by W. C. Clark.

For years mill men in the Coeur d'Alenes have been studying and theorizing over a method of saving ore closer than the concentrators will do it, and while many improvements have been made in milling methods still now the very best that can be hoped for from any of the concentrators in the district is that 85 per cent. of the ore in the feed will be included in the concentrates. Often 25 per cent. of the ore is lost, and it is doubtful if the average saving will exceed 50 per cent. of the ore in the crude ore.

The 10 concentrators in the camp are handling between 4,000 and 5,000 tons of crude ore daily, from which they are saving about 600 tons of concentrates, but at the same time 125 tons of ore, carrying 66 tons of lead and 4,200 ounces of silver go into the South Fork of the Coeur d'Alene River and its branches. This, could it be saved, would be worth almost \$8,000, or after deducting freight and smelter charges, \$5,500, for an average of about 340 days out of each year.

So far as is now remembered the first effort to save any of the values after they left the concentrators was made by W. A. Bradley, a millwright now in South America superintending the erection of a plant for Fraser & Chalmers. He put up a small plant at Gem, taking water from the creek, carrying it through a flume to a settling tank and running the settlings over a table of his own manufacture similar in plan to the Wildie table. It was operated for a couple months, when it was abandoned, experience showing that the ore saved was not quite worth the wages of the man employed to run it. Lead was then worth considerably less than at present, and silver a little less, besides which there were some errors in the plan. Where the water was taken from the creek, the stream was crowded into a narrow space and instead of a dam the upper end of the flume was simply let part way down into the water. This was for the purpose of getting rid of the coarser material which washed down on the bottom of the creek, but it also resulted in getting the poorer part of the water, that carrying the greatest amount of ore naturally being near the bed of the creek. After the project was abandoned Mr. Bradley admitted that it might have been made to pay by taking the whole stream and running it through a trommel at the head of the settling tank and throwing the coarser part back into the creek. The power used to run the plant was derived from the overflow of the settling tank so there was no trouble on that score, the canyon through which the creek runs having sufficient fall to furnish any desired amount of fall for the overflow. Another, and more serious fault, was that the plant was run on too small a scale. Had it been increased to three or four times its capacity, and there was nothing to prevent it, good pay would have been secured, as the running expense would have been no heavier. It ended, however, in practically nothing except satisfying those who saw it that it was useless to attempt to save values from the mere sediment carried along in the water.

Later one or two other experiments were made in the vicinity of Wardner, but they, too, were pronounced failures and the public abandoned hope.

The banks of the streams below the mills, however, where the constant lap, lap of the waves makes layer after layer of galena in the form of slime, kept some men thinking, and last spring J. A. Green started to build a plant according to his own plans, selecting a site in Wardner a short distance below the Last Chance mill, to try the experiment. The situation was the most favorable in the whole camp as at that point the canyon is so steep that it was only necessary to flume the water about 100 yards in order to get enough fall to drive his machinery by the overflow, and at that time the Last Chance mill, owned and operated by the Empire State-Idaho Mining and Development Company, was unusually short of machinery to handle slimes and it was also being crowded to its fullest capacity. He located so near the mill that there was no loss from ore settling before he took it from the creek.

At the mill site he built "V" shaped settling tanks, four in number, each about 30 feet long, about two feet across the top and the same in depth. Into these the water was run from the flume, a gate permitting him to run it into either one at pleasure, or to divide the stream. After flowing out of one tank it passed into another, and from the second the water went to an overshot wheel two feet wide by eight in diameter. This wheel drove a four-foot Frue vanner, the only bit of machinery in the plant, and the only thing which moved except the power wheel. Hiring a man to run it one shift opposite to himself, as the result of 57

days run Mr. Green had shipped two car loads of ore, for which he received \$844 after paying freight and smelter charges.

Not only had he satisfied himself that the experiment was a success, but he had also found that, although using only part of the water coming down the creek, he could not use one half of the product of the settling tanks with the one vanner. The next step was to build a round table which he expected to handle all that would settle in his tanks, and only the middlings from that table will be run over the vanner. The plant in this form has only been running a few day at the time of the present writing, and nothing is yet known as to the results beyond Mr. Green's statement that it was running to perfection.

About the time that this plant at Wardner was fairly started, Thrasher & Salsbury, two experienced mill men, began work on a similar one in Wallace. Here the conditions were hardly so favorable as to first cost, it being necessary to flume the water about 1,000 feet before getting fall enough to run the plant with the overflow. Flat bottomed settling tanks were first built, but after a thorough trial they were taken out and "V" shaped tanks built instead, it proving too difficult to draw the sediment from the flat bottoms.

Four of these tanks, each 40 feet long were built, the water running throughout the whole length of the four, and the overflow driving the overshot water wheel. The head of the flume was on Canyon Creek just below the Standard and Mammoth concentrators, the plant being located on the opposite bank of the South Fork a short distance below the mouth of Canyon Creek, and fairly within the limits of the municipality. There is so little fall to the creek and river here that the bottom of the settling tanks were only nine feet above the level of the river, and it became necessary to elevate the feed to reach the vanners. There were two in number, of the Frue variety, four feet in width, and it was found that there was no trouble in running them and the elevator with the overflow, although it was found needful to divide the stream and run it over two wheels, the larger of which was only 18 inches wide and about six feet in diameter. No sooner were the two vanners started up than two others were added to the plant, but there was not power enough to run them, or rather in order to run them it was necessary to run the water through the settling tanks so hurriedly that not enough of the solid contents settled to keep the vanners in feed. To overcome this difficulty two more settling tanks, each 100 feet long, have been built, they receiving water direct from the flume and pouring the overflow directly upon one of the water wheels, while the other is driven by the overflow from the old tanks. The remodeled plant has just been started up, although the first two vanners were kept running while the new tanks were being built and a car load of slime has been shipped from them. Returns have not yet been received from the smelter, and the work has been too much of an experimental nature so far to enable even the owners to have a definite idea as to the profit which may be expected from the plant.

Shortly after Thrasher & Salsbury started to work here some other mill men began work on a similar plant at Gem, the location chosen being just below the mouth of the Hecla and Frisco tail races. Two Frue vanners were put in there, but the calculation had been bad, the plant being so close to where the water was taken from the stream that the overflow did not furnish sufficient power to drive the machinery without running through so much water that there was not enough settling tank room. Then the owners became disgusted with their venture, and last week the plant and water right was sold to Thrasher & Salsbury for \$1,200, and they are now engaged in tearing down the plant, and will move it 1,000 feet farther down the creek, from which point they can get a fall of 22 feet for their overflow water, giving them power to run all the machinery needed, even though the plant should be greatly enlarged.

The success of these ventures has resulted in the location of a number of other water rights at other points for similar purposes, although nothing has yet been done in the way of building another plant. It has had the effect, however, of stimulating the big mining companies to renewed efforts to save their ore, the Mammoth adding seven six-foot Frue vanners, while in other mills there have been additions along similar lines. The tailings men profess to be indifferent about this however, asserting that there is and always will be enough slime turned into the creek to accommodate dozens of the little plants working from one to four vanners.

There is a large loss of ore also in the form of the tailings from the jigs. This has been forcibly brought to the attention of everyone this summer by the use of tailings to pave the streets here in Wallace. The tailings used for that purpose are from the coarsest jigs, and are of a size similar to that needed for macadamizing. This rock will run from one-half to two per cent. or more in lead, with rather more than an ounce of silver to a per cent. of lead, giving the rock a value of from 75 cents to \$3 per ton, and

there is being considerable studying and a little experimenting done to devise a means of handling that character of ore. It requires a more expensive plant than the slime, as besides all that the slime plant contains it must also be able to crush and jig the rock, and there is not the opening for poor men that there is in the slime mills. The latter, with a single vanner, bought at second hand, can be put up by a good mechanic at a cost of from \$100 to \$300, depending on the location, amount of flume and tanks needed, etc., while the former will require an expenditure of not less than \$2,000 and probably considerably more to build a plant on a scale which would pay expenses. It is admitted, however, that there is much more value going into the creek in this form than there is in slimes, and the inventor and experimenter has an unexplored field in which to delve, with the assurance of an immense fortune at the end of the goal if the proper route is only discovered.

VOLUME OF SMALL DRIFTS

And Working Places—Method of Finding by Use of Strings and Measurements Where It Is Impossible to Use a Transit.

By C. S. Herzog, Virginia, Minn.*

In the *Engineering and Mining Journal* of Jan. 27, 1900, there appeared an article by Fred T. Greene, describing a method of measuring stopes by the use of strings, a clinometer and a tape.

In the early part of 1899, I had occasion to use a somewhat similar method, for the purpose of accurately ascertaining the volume of a very irregular drift, connecting two mines. This drift was an important factor in a lawsuit for \$150,000, in which it was necessary to determine accurately the volume originally occupied by the material extracted from the drift.

While it is unnecessary to give all details of the controversy, some explanation of the conditions is required for a clear understanding of the following description. This drift was started by the "K." Co. from its workings, in about 7 ft. of ore, and headed toward the "G." property, the plan being to extract all the ore between foot- and hanging-walls, but to take out nothing but ore. As the "G." workings were approached, the ore-body became very irregular and much thinner. It was, however, very closely followed, and where the drift broke through into the "G." workings, the hole was only 11 inches high by 14 inches wide, or just about the size of a man-hole in a boiler. Thus, this connection-drift tapered sharply; and the very irregular foot-wall sloped toward the "G." workings, and entered them at a place where the stope was only about 3 ft. high, and the ground had already commenced to cave. It may be added that the ore body was a nearly flat deposit of lead carbonate in limestone, the ore and gangue being quite soft.

I was called upon by the "G." people to make the survey required to show the relation of this drift to their own workings. The opening into their own stope being so small, the roof being so low, and the drift itself being so irregular, it was quite impossible to get any satisfactory results with the transit in the ordinary way, because it was impossible to set up the instrument in any position outside the hole so that a new station could be located within, high enough to permit setting up the instrument. Upon consideration, I devised a method which gave us the volume very accurately and tied this drift to our other workings. What was sought was a series of parallel cross-sections, at a known distance apart, from which we could calculate the volume, as in railroad earth-work.

About 7 ft. in front of the 11 × 14 in. hole, and about square with it, stood a 12 × 12 in. post. A horseshoe nail was put in each of the two edges facing the hole. Two nails were now driven at A and B, Fig. 1, into the roof of the drift as far inside as was feasible, and strings were stretched between them (*aA* and *bB*, Fig. 1).

Then working up from the nearest station, a new transit station, I, was located as far away as possible, yet in such a position that all the string outside the hole was visible. From this station two points on each string (*a* and *a₁*, *b* and *b₁*) were now carefully located and marked by means of fine piano-wire wound around the string; *a* and *b* were placed close up to the nails in such a manner that a line connecting them would make about the same angle with each of the strings; *a₁* and *b₁* were put as far along the strings as they were visible from the instrument.

Sighting at *a*, the distance *Ia* was measured and the vertical angle was read. The angle *aIa₁* was next turned off and read, after which the distance *Ia₁* was measured, and the vertical angle was read. Thus we had two sides and the included angle of the triangle; however, as a check, the distance *aIa₁* was measured. A similar operation was gone through with *bIb₁*. In this manner

the plane of the two strings was accurately located. The next step was to measure the distances *aA* and *bB*. This done, as many parallel cross-sections as were desired could be obtained with the aid of plumb-bobs, nails, fish-line and a tape. The locations of these cross-sections were selected in an arbitrary manner, according to the irregularities of the drift, so as to obtain the precise volume.

The *modus operandi* was as follows: Let us assume that a section was desired at, say, *a₂ b₂*, Fig. 1. The distance from *a* to *a₂* was measured along the string *aA*, say 16.3 ft.; the same distance, 16.3 ft. was laid off on *bB* from *b*, and each point was marked with a lead-pencil on the string, or by a string tied around the point. Nails were then driven in the roof, directly over these points, in such a manner that plumb-lines suspended from them just touched the strings *aA* and *bB* at the marks, *a₂* and *b₂*. By this means, two points in the roof (*c* and *d*, Fig. 2) and two points in the floor (*e* and *f*) were fixed, by measuring the distances *a₂ c*, *a₂ e*, *b₂ d*, and *b₂ f*.—It was found convenient in most cases to mark the points in the floor with nails.

Points *g* and *i* were next located by stretching a string across the drift, so that it just touched at *a₂* and *b₂*; and then the distances *a₂ i* and *b₂ g* were measured. It will be seen that *g* and *i* are points in the plane of the strings *aA*, *Bb*. Point *h* was next located by making an offset of, say, 0.9 ft. from *a₂* toward *i*, and measuring vertically to the roof. Point *k* was fixed by measuring, say, 0.8 ft. down both from *a₂* and *b₂* and measuring across the plane of these two points, which is parallel to the plane of the two main strings.

As many points as are desired may be located in a similar manner, the main idea to be kept in view being that all measurements should be made vertically, or in a plane parallel to the plane of the two main strings.

A sketch of each separate section is made in the note book and all the measurements are marked thereon; the sketch being

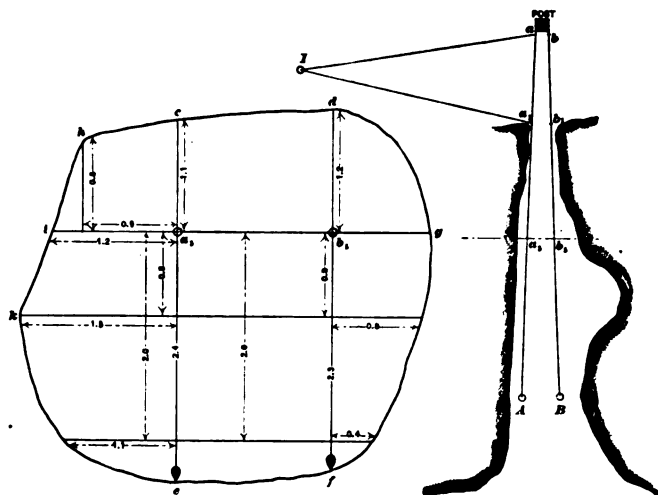


FIG. 2.

FIG. 1.

labelled at the top of the page with the distance from the initial points *a* and *b*.

Having secured as many sections as are desired, the office work to be done consists of a series of very simple calculations. From the work at the instrument, after the proper calculations have been made, the plan and elevation of the plane of the strings can be drawn, and from these the horizontal distances between the different sections can be scaled off; or, knowing the angle of inclination of the two strings, we can calculate the distances horizontally. Each cross-section can be laid off accurately with triangle and T-square, and the area can be calculated in the ordinary way.

Having calculated the areas of all sections, and knowing the horizontal distance between each two, the volume of each prism can be obtained by the formula:

Volume equals one-half the sum of the area of the two bases, multiplied by the altitude—the bases being any two adjacent sections, and the altitude the horizontal distance between them. The sum of all the volumes gives the total volume, up to the line across the two points *A* and *B*.

From our previous work we have the location of these points *A* and *B*; to obtain the remaining volume, we set up our transit under either *A* or *B* and proceed to make cross-sections from our instrument in the usual way.

It should be added that the two sketches shown herewith are hypothetical, as I have no drawings of the real workings at hand.

*A paper read at the Canadian meeting of The American Institute of Mining Engineers, August, 1900.

APPANOOSE COUNTY COAL FIELD.

A Description of the Coal, The Methods of Mining and the Use of Machines in Thin Veins.

Written for MINES AND MINERALS, by J. J. Rutledge.

In and about the city of Centerville, in Appanoose, one of the counties in the southernmost tier of Iowa, and adjoining Missouri, is found a very interesting coal field. While all the mines are small, having outputs varying from forty to two hundred tons per day, they differ from other mines in many respects.

The coal is a semi-block, found at about one hundred and forty feet depth, lying approximately level and having an average thickness of two and one-half feet. The seam is covered by a black slate averaging one foot in thickness; which slate is brushed on main and cross-entries. Above the slate is a limestone varying in thickness from one to two feet. The coal seam proper is made up of twenty inches of top coal, a clay or mud seam of from two to three inches thickness, a lower coal eight to ten inches thick, a clay parting mixed with pyrites of iron, from one-half to one and one-half inches thick, called the "Dutchman," and a bottom coal from two to three inches thick, of varying quality. Below the bottom coal is found a soft fire-clay from one to one and one-half feet in thickness; this fire clay rests upon a limestone or "bottom rock," three to six feet thick.

The mines have a good demand during the fall and winter, but do comparatively nothing in the spring and summer.

The ordinary system of working is by pillar and room or some of its modifications. In some mines true longwall or some modification is used.

The surface plants are small, costing from \$5,000 to \$7,000, and are generally equipped with double, second motion hoisting engines, as the depth is not great. In some mines the coal is reached by drifts and slopes.

This coal field is remarkable in several respects. Machines for mining coal are not thought to be profitable except in seams comparatively thick, yet here we have machines successfully mining coal only thirty inches in thickness. Moreover, two different kinds of machines are used, one for mining and one for shearing ribs or "corners." Still further, while powder is generally used to break down machine mined coal, in this field not one pound of powder is used upon the coal. The coal is of such a nature that powder shatters it and makes an unmarketable product. The only powder used in these mines is that consumed in brushing the black roof slate on main and cross-entries. Again, it has generally been accepted as a truth, that machines can only be worked successfully under a good, strong roof, while in the Appanoose coal field, the coal is mined successfully under a weak, draw slate, and the work is done by mining machines requiring a space of twelve feet between the gob and face of coal. That the use of mining machines is profitable, is evidenced by the mines using machines being in operation in dull seasons, when hand mines are shut out of the market by reason of their higher cost of production, and by the introduction of new mining machinery in this field.

The Centerville Block Coal Co. is the largest operator, owning and operating some eleven mines, both hand and machine. There are other companies operating from two to three mines each, and a number of small local mines. Pillar and room, double entry, as followed in this field, is very simple. Main entries and parallel air-courses are generally driven with a twenty-four foot pillar between. Cross-entries are turned off the main entry at distances of three hundred feet, and the cross entry is separated from its parallel air-course by a twenty-four foot pillar. In some cases the main entries and cross entries are brushed from top rock to bottom rock. No timbering is required on main and cross entries, as the roof arches itself in being brushed. Room door-ways in hand-mining are generally turned eight feet in width and driven in ten feet before widening out. About twenty feet of pillar is left between two adjacent door-ways, and when driven up ten feet, they are widened out to meet, the widening out being made on an angle of 45 degrees. This gives a room forty feet in width having a "wheelway" on each rib. The stub on entry between "door-ways" varies from twenty to twenty-four feet in width. After the room has been widened out the space between the two wheel-ways is tightly built up with gob and pack-walls. Rooms are driven one hundred and fifty feet in length.

The miner undermines the coal, in the fire-clay, to a depth of about eighteen inches, from rib to rib across the room face, and then shears each rib to cover the depth mined, and wedges down the coal. In most hand mines from four to six inches of the draw-slate next above the coal are taken down, as coal wedges better after this is removed. This draw-slate makes excellent material for the pack-walls supporting the fire-clay made in gobbing.

A twenty-foot pillar is generally left between adjoining rooms, though in some cases this, too, is worked out, only the entry stump being left to support the roof.

Two men work in a room, one on each wheel-way; all coal is pushed from the working face to the room-switch by the miners, as wheel-ways are not brushed.

By pillar and room, which is the most prevalent system of working, the yield per acre is about two thousand tons of merchantable coal. About ninety per cent. of coal mined is lump coal. All coal is paid for on the railroad car, over a regulation six by twelve feet one and one-quarter inch bar screen. The price is ninety-five cents per ton, for hand-mining. The average yield per day, for hand mining, is two tons per man.

The seam is suitable for longwall and is worked by such methods at Numa and Mystic, but the only advantage seems to be in getting all the coal, as against the sixty per cent. gotten by pillar and room, as both yield the same per cent. of lump coal—90 per cent. Longwall coal, mined by mining machines, does not yield as good quality of lump as does pillar and room coal mined by mining machines.

The yardage for eight feet entries is \$1.25, and door-ways are \$2.00 each. Clay slips and seams intersect the coal, and the roof-slate is often replaced by a heavy, earthy, non-fissile mass called "black bat," or simply "bat." These obstructions to mining are generally reckoned as deficiencies and are generally paid for at an addition of from five to ten cents per ton to mining price. The "bat" often attains a thickness of two feet and reaches clear across a forty foot room. It is very dangerous, being hard to hold up and giving no warning before falling. Nearly all the fatal accidents in this field result from fall of "bat."

The cost of delivery of coal to railroad car from face, driving, company-work, hoisting, dumping, etc., is generally reckoned from thirty to thirty-five cents per ton above and in addition to the mining rate.

In mining this coal by machine the Centerville Block Coal Co. employs the Legg cutter-bar machine for mining, and the Harrison puncher machine for shearing. Norwalk air compressors are used for operating these machines. These machines are used very successfully in driving entries and in turning rooms.

The mining machine is operated by a runner and his helper. The machine undercuts the clay in entries and door-ways so that about eight inches of clay is taken out below the coal. In entries and door-ways this fire-clay, made in mining, is loaded in cars and sent to the surface waste heap. In rooms the mining is not so deep and all clay is gobbed. One yard of entry, including coal loaded and clay moved, costs about \$3.00.

Before shearing machines were introduced, ribs or corners were cut by hand, the price for a corner cut five feet deep being 87 cts.

The cutter-bar machines undermine the coal to a depth varying from four to five feet, and the machines undercut from two and one-half to three 40 ft. rooms in a day of eight hours. The Harrison shearing machine cuts from sixteen to eighteen corners per day of eight hours. The price paid for undercutting is $\frac{1}{2}$ cent per square foot; at this rate the Legg runners average \$3.00 per day. The Harrison runners are paid $4\frac{1}{2}$ cents per square foot, in rooms, and $5\frac{1}{2}$ cents per square foot in entries—about 38-40 cents for each entry cut. It is necessary to cut the clay deeper in shearing entries and an additional cent is paid for this work. The Harrison runners average about the same as the Legg runners.

Both Legg and Harrison machines require two men to operate them, and in addition to these two men, each machine is followed by a "third man," who loads the clay thrown out by the mining machines in entries and door-ways, gobs the mining-clay in rooms, and loads out the cuttings made in shearing ribs. He also moves and resets the props which the machine encounters as it moves across the face of the room. When paid by the day the runners receive \$2.50 per day, helpers \$2.25, and "third men" \$1.90. The loaders receive 44 cents per ton on railroad car, and 15 cents for the extra clay moved in loading out the coal in entries and room necks. The loader moves the clay found under coal in rooms twelve feet back from face of coal, and receives no extra pay for so doing, as such work is included in the loading price. Loaders make from three to four dollars per day, depending on inclination and individual ability. The company lays all track in rooms and entries for the loaders.

The machine-boards for Harrison machines are hinged in the center, lengthwise, to permit of their being folded together. The machine-trucks have holes cut in bottom for machine wheels, to admit of easy handling in the low coal.

The machines show an advantage of from ten to fifteen cents per ton over hand mining. They have an especial advantage in driving entry and turning rooms, doing the work cheaper and faster than by hand.

The price of screened lump coal, at mine (no mine-run coal is sold in this district), is \$1.75 per ton. The cost of production for

hand-mined coal varies from \$1.25 to \$1.50, not including royalty, which is from 5 to 6½ cents per ton. This royalty is sometimes paid only on room coal. Machine-mined coal has been produced as low as \$1.16 per ton. The railroad contracts have been taken as low as \$1.17 per ton, but this year the price is \$1.40 per ton.

Coal land, when bought outright, costs from \$10.00 to \$15.00 per acre.

The coal vein lies approximately level, and haulage-ways are nearly level. As a rule, the mines are dry, and the cutter-bar machine works under favorable conditions.

The rooms in hand and machine mines are generally driven one hundred and forty feet long and have a width of forty feet. Lately, rooms in machine mines have been driven sixty and eighty feet in width. The extra width is an advantage in using mining machines, in this coal, as it is not necessary to make as many moves, from room to room, in order to mine the same amount of coal, as is the case with the narrow rooms.

One mine in this field, has recently been equipped with Jeffrey electric mining machines brought from another field. The 6 feet Jeffrey mining machine is used for undermining, and mines to a depth of 6 feet. Morgan-Gardner electric chain-shearing machines are used for cutting ribs. Both machines are self-propelling which is quite an advantage in this low coal. A Morgan-Gardner electric puncher is also in use for shearing ribs. The electric shearing machine cuts the entire thickness of vein at one setting. This machine has frequently cut through sulphur bands 1½ inches in thickness.

Lee Brothers, local coal operators, have produced an electric machine, for long-wall mining, which is peculiar to this field, and has been brought out to meet local conditions. See MINES AND MINERALS, Oct. 1899, Vol. XX, page 112, for description of Lee longwall machine. The machine is six feet in length, two feet in width and two feet and three inches in height. It consists of a heavy cast-iron frame built in two sections, which bolt upon each other when placed horizontally, something in the way the frame of a "Terrapin Back" electric haulage locomotive is built. A seventeen-horsepower motor, with armature set parallel to horizon, furnishes the power for mining. The power is transmitted from the armature shaft to a cutting-bar by gearing. The cutting bar mines in the clay, immediately below the coal; and the cutting-bar is a tapered steel bar, three feet in length, upon which is fitted a steel strap bearing teeth. When the cutting bar becomes dull, it is only necessary to throw aside the dull strap, fit a sharp one on the tapered bar, and replace bar ready for cutting. The item of repairs for cutting bar is quite small on this machine, at one plant the engineer being able to do all repairing and maintenance of six machines, in addition to firing, care of engine, generator, etc. The machine is fitted with wheels, and, although weighing thirty-two hundred pounds, is quite easily taken from one end of the long-wall face to the other.

When one end of the semi-circular face has been reached the wheels and axles, which support the machine while being moved, are taken off machine, and by means of the jacks (whose handles appear at rear end of machine), the machine is lowered upon the sprocket wheel and guide-wheel. Sections of steel-tracking, twelve feet in length, are provided upon which the machine runs as it mines. The guide-wheel at gob-side of machine rests upon a pair of 2 in. X 2 in. steel angles, bolted together, back to back; while the sprocket wheel fits into a steel rack. The point of the cutting-bar is raised or depressed by means of the jacks. Formerly it was necessary to cut an opening by hand, under the coal, before the cutting-bar could be inserted and machine started. Now, the machine is fitted with a slow motion screw by means of which the cutting-bar is fed into the clay by motor without aid of hand-mining. When the cutting-bar has attained a position at right angles to the machine, it is bolted in place by means of a bolt.

The machine advances along the face at rate of one foot per minute, the cutting-bar making a cut to the depth of thirty inches—the thickness of the vein. The cut made averages six inches in height. As the machine passes over one section of track, another length is passed over the machine, and laid in path of its advance. Props and pack-walls can be kept as close to face as twenty-seven inches, and there will be no hindrance to passage of the machine. As the height of machine, over all, is only twenty-seven inches, there is abundant room under the draw slate for moving the machine. The yield for each machine is fifty tons per day of eight hours. It is necessary to have all projecting pieces of coal taken down, in order to insure a uniform depth of cutting. An average day's work, including all moves, is one-hundred lineal feet of face cut in eight hours. At the end of the longwall face, where the coal abuts old work, it is generally necessary to mine out a loose end. This item is small, as the miner is generally paid at hand mining rates for cutting the tight end, and the custom is to allow one ton for each tight end mined. The machine has the advantage of being able to move itself across the coal face in much the same manner as a mowing machine is moved along one side

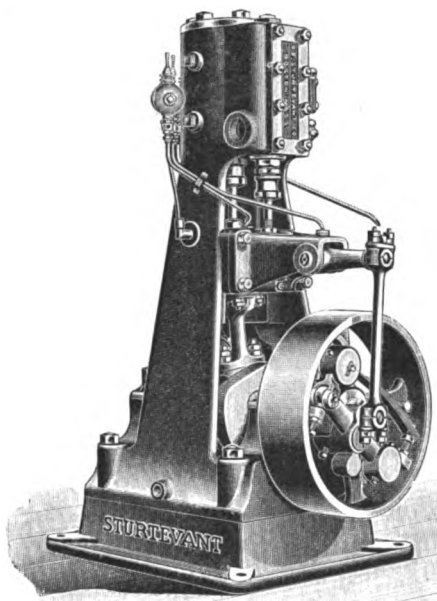
of a field of grain. Indeed, the action of the Lee machine strongly suggests a mowing machine. In well-developed long-wall it should be necessary to make very few moves, perhaps none at all, and the Lee machine would then have a decided advantage in that it would be mining coal during *all* the time it was moving.

The machine is compact, strongly built, requires few repairs, and small amount for maintenance and is sold for about same price as other electric longwall mining machines.

A Substantial Type of Small Vertical Engine.

The accompanying illustration presents a type of small vertical engine adapted to general use, which has recently been brought out by the B. F. Sturtevant Co. of Boston, Mass. It is built in three sizes ranging from 2 to 4 H. P. with speeds of 1,000 rev. for the smallest size and 650 rev. for the largest.

It is in aspect a perfect miniature engine, complete in every detail and designed with the utmost care. The frame is rigid in its design, spreads well at the base and resists vibration, notwithstanding the fact that the weights have been kept down to the minimum, ranging from 160 lbs. for the smallest up to 450 for the largest engine. The steam is distributed by means of a piston valve actuated by the automatic governor which as will be noted



is complete in all its features. The effect of the reciprocating parts is overcome by suitable counterbalance of the crank plates. The connecting rod is of the marine type. All moving parts are adjustable for wear and a complete oiling system is provided for the individual bearings. The cylinder is lagged, to reduce the condensation, and access to the piston valve and steam chest is provided by means of a removable cover.

This line of engines was primarily designed by the Sturtevant Co. for use with their generators in torpedo boat service where the minimum weight was absolutely essential. The same type of engine is built to be operated by throttling governor and is also very generally employed for fan driving, being then directly connected to the fan shaft. The cylinder is tapped for indicator and is also provided with the necessary drip valve connections. The small diameter of the cylinder and the extra thickness of the walls makes it possible to run these at a pressure of 150 lbs. and even higher, although the powers above specified are those developed at 80 lb. initial pressure.

The smallness of this engine can be realized when it is stated that the steam cylinder is only 2½ X 2½ in., and the total length of the plate covering the valve chamber is only 5½ in.

The production of pig-iron in the Dominion of Canada in the first half of 1900, according to reports which have been received by the American Iron and Steel Association from every manufacturer of pig-iron in the Dominion, amounted to 45,234 tons. The total production during the whole of 1899 amounted to 94,077 tons, against 68,755 tons in the whole of 1898. Of the production in the first half of 1900 about one-sixth was made with charcoal as fuel, the remainder being produced with coke alone.

MINING

At the Paris Exposition—A Description of the Peculiar Features of the Industry as There Illustrated.

By David T. Day, Ph. D.*

The greatest feature of the Paris Exposition was, without doubt, solving the problem of finding room for it in the heart of a city that has been crowded for centuries. This proved, also, the most puzzling feature to the general visitor for it was necessary so to fit the Exposition into irregular vacant space that a general group of the arrangement was difficult to obtain. To offset this the effort was made to group all exhibits of the same class in the same place thus

The exhibits of mining and metallurgy were grouped as completely as possible in the eastern third of the main exhibition palace in the Champs de Mars, appropriately near to that great monument to structural steel and the engineering profession, the Eiffel Tower.

The Mining and Metallurgical Palace itself calls for some passing notice. There are very few windstorms in Paris, hence lighter construction was possible than would be safe in this country. This was utilized so that the building afforded a maximum amount of light even with a very large system of galleries. In front of the entrance French Art was most successful in symbolizing "Mining," on the one entrance, and "Metallurgy" on the other, by groups of statuary of unusual merit.

On entering the building it only requires a glance to recognize that France has passed the position of a mineral producer and has gone far into the next stage of metallurgical importance, the treatment of ores and the utilization of their products.

This end of the Mining and Metallurgical Palace is in the form of a vast rotunda filled with the evidences of France's metallurgical activity; no mineral products or illustrations of mining products are in sight, while in every direction are massed the most eloquent evidence of the ability of French iron masters to execute large and difficult problems.

Besides huge specimens of boiler plates, heads and forgings, there was a very elaborate exhibit of a revolving steel turret and its gun. Just by the entrance were the forgings, projectiles, tires, etc., of the great Saint Chamond steel works. Opposite were the gun tubes, forgings and steel plates of Marrel Freres.

Adjoining was a model of a steel mine shaft which represents a piece of work 45 feet in diameter and over 400 feet in length which was sunk by the freezing method to reach a body of the Minette iron ore. This Company also makes annually 60,000 tons of cast iron pipes of which there was a gigantic display.

Nearby rose two enormous columns of seamless tubes of brass, copper and steel from the Saint Vaast foundry. But the center piece of the building, to which all the aisles lead, was the display of the great French Copper Company. It was by far the most impressive feature of the palace. It is good exposition work. It serves the purpose of showing what can be accomplished at an exposition in conveying to people an adequate idea of the grandeur and dignity of a mechanic art, calling the attention of the world to the progress of an industry and securing for the exhibiting company a standing in the market for its products such as it could not easily gain by other means. This is the great copper company of which a member, M. Secretan, once tried to corner and control the copper and tin markets of the world.

The instructive feature is the variety of objects made of copper which we would make of steel. The French are great users of this durable metal—copper, and we find the exhibit framed in by eight copper tubes made without seams by the Ellmore electrolytic process. They are about two feet in diameter and 32 feet long and weigh over two tons each. There are surmounted by smaller tubes gracefully joined by a cornice at the top. Within the enclosure thus formed is a pyramid of copper objects of every description, including copper and brass sheets, tubes, copper and brass wires and rods, even a copper locomotive fire box. And as an artistic finish a copper bowl over 10½ feet in diameter and weighing a ton and a third. In so far as an exposition can effect an industry, this collective exhibit presents French metallurgical establishments more favorably than they have ever been known before.

The technical processes for the production of copper, lead and zinc are shown most effectively even though there is no special effort at novelties in technical method.

But mining and the minerals which form the basis for this metallurgy? They are relegated to the gallery. There, the visitor finds that no pains have been spared to show by models of mine workings, geological sections, mine maps, and every other costly and elaborate device, the conditions in which the French deposits

of iron ore, coal, and many other minor industries, including asphaltum, are found.

The mining and transportation methods are also shown pictorially and by models, so that the results of relatively cheap labor can be compared with our somewhat different methods. The exhibits are rather unusually faithful expositions of old conditions rather than demonstrations of specially novel devices.

France has one mineral article which she exports to an interesting extent, although the substance is humble bituminous limestone. All the peculiarities of this industry are shown including the useful distillation products which this asphaltum can yield. The importance of this substance is recognized when we think that not only is Paris paved to quite an extent with this bituminous rock, but it is exported even to New York.

It must be remembered that in France aluminum was first produced industrially and thanks to plentiful supplies of cheap bauxite, France is now one of the great manufacturers of aluminum and also a great believer in the future of this metal, as was shown by endless variety of manufactures from it which formed one of the novel features of the building.

Not content with utensils and all manner of fancy articles of pure aluminum, and with spun and drawn objects, tubes and sheets made of quite rigid aluminum which has been strengthened by 15 per cent. of nickel; a new alloy, "Partinium," is shown where tungsten stiffens the metal and the added weight is almost balanced by the addition of magnesium, still lighter than aluminum. Great claims are made for this as a light and strong substitute for brass in castings.

To continue a study of French mining, we must leave the Mining Palace and the Champs de Mars itself and walk (there is no means of conveyance except very bad roller chairs which we would have scorned at our Centennial, if we had had them) to the Trocadero, where as a mockery at the firm resolve at a rigid installation of like with like, the exigencies of space have sequestered the ideal of all mining exhibitions, a good imitation of a mine on the scale of a real one, which cost two to four times as much for admittance as for the whole exposition itself.

The mine could be entered by walking down a slope or by a shaft and hoisting apparatus designed for a great colliery where it will lift six tons of coal in one cage, a distance of 1,800 feet in less than one minute, which is a fair pace, even in this country. At the bottom of the shaft you are met by miners with suspiciously clean suits, bearing numerous crossed hammers, who conduct you through a most carefully arranged exposition of old and new mining methods, timbering in all forms, mine haulage, and drilling appliances. Coal mining is first illustrated, then the visitor is taken into a mine of iron pyrite, then through rock salt, slate mining; glimpses of South African gold mines, and (for extra compensation) a Colorado gold mine.

The mine was ingeniously arranged under the Trocadero Palace and divided the space with another under-ground curiosity called the subterranean world where sensational rather than conservatively educational exhibits were to be seen.

In absolute defiance of the French ideals of classification several other collective exhibits of mining were to be found in the Trocadero among the colonial exhibits; the graphite and gems of Ceylon, various minerals from Cuba, a goodly collection from Algiers, including new petroleum developments. The wonderful Baku petroleum fields were exhibited on a large scale by the Nobel Brothers. And Canada made a splendid showing of mineral wealth in its special building. This included, especially, the sections showing the gravel from grass down to bed rock in the Klondike mines. The collection of gold nuggets from this region was fascinating.

But by far the most unexpectedly fine showing of the mineral resources of a country was furnished by the wonderful collection of gold nuggets, sand, dust and ores from West Australia. Not only were the nuggets most beautiful and valuable, and specimens of crystallized gold equally attractive, but the exhibit included profuse specimens of all the tellurides discovered there, the specimens aggregating \$200,000 in value. There is no question but what this exhibit by its excellence has been of greatest value to the country itself.

Going seven miles further away from the Mining Palace we find the most useful exhibits of mining machinery, installed at the Annex Exposition at Vincennes. Here were rock drilling and other mining machinery in actual operation, and mining methods were further illustrated by a full sized petroleum drilling plant in operation.

Foreign mining and metallurgy was installed in the Mining Palace, where we find the main exhibits of Sweden, Norway, Denmark, Italy, Spain, etc., all demonstrating the prominence of the metallurgical stage of their development.

The Swedish exhibits show admirably their conditions of mining, especially the condition of occurrence of certain iron ores for which relief models were used.

* Lecture before the Museum of Natural History, New York City.

New methods were shown of illustrating the changes in the structure of steel by the effects of changes in temper and by chemical composition.

As usual with the older countries, the metallurgical side of the mining industry predominates in Sweden, and, as we know, Swedish iron is not only a very old and familiar member of the iron family but it has represented the very finest product in metallurgical development. This seems natural from the extreme age of the works. For instance, the Stora Kopparberg was founded in 1225, and this establishment still produces some copper and copper sulphate, after 700 years of continuous working, during which it has furnished about half a million tons of copper.

About 175 years ago they introduced the manufacture of iron and steel, and as a part of their estate consisted in an enormous timber tract which furnished the charcoal for the iron works, this timber feature has led to further industrial developments by which, from saw mills for the lumber, they have extended to mills for paper pulp and now include the manufacture of paper itself.

It must be remembered that while this is the largest plant in Sweden, it does not turn out more than 50,000 tons of products in a year, which would be a small yield for one of our minor steel works. It makes up, however, by the exquisite grade of these products which have long been the standard of the world, and are likely to remain so for, as the plants in other countries succeed in rivaling their products, Sweden advances her product and raises her standard a grade higher.

In addition to metallurgy, the mineral basis in Sweden has not been neglected. The exhibit of ornamental red and black granite and other building stones is magnificent, and most interesting is the large view of their great iron ore developments up in the Arctic Circle, where arrangements are being made for producing 800,000 tons of iron ore in a single year, most of which will be consumed not in Sweden, however, but by the German steel mills.

Russia's combined position as a great source of future and present mineral supplies, together with very considerable metallurgical developments, was well shown, especially by the displays of coal, gold, petroleum, rock salt, platinum, stones for building and ornamentation, and most remarkable from the metallurgical point of view by the Kyshtim iron foundry and the wonderfully artistic effects produced by a foundry in this isolated position.

But more impressive and systematically presented were the mineral features of the United States exhibit, arranged behind an enormous facade, 160 feet long. By being made of iron with frequent columns of beautifully polished marble and granite columns, the facade was itself a mineral display of great value. A gallery was also filled with specimens representing minor metallurgy and hardware.

At the ends of this long space were exhibits from two of our great combinations, the Standard Oil Company and the American Steel and Wire Company.

Our experience in the exposition art since the last Exposition in France in 1889, has made us well calculated to display effectively our wonderful mineral developments and the expectation was handsomely realized, by this exhibit organized by Mr. F. J. V. Skiff.

The exhibit of the American Steel and Wire Company was a marvel of what can be displayed in a small space. The plan included the iron ore, limestone and coke (all from the company's own property); with these as a basis all the forms of crude iron, steel, zinc and copper were shown, of which nearly 8,000,000 tons are used annually by this firm; from it the products proceeded from the simpler to the most detailed products of copper, iron and steel for which use can be found. Wire of every form was the predominant product. It was arranged in column after column, according to its various uses. One had at its base reels of wire rods, upon which rose coils of wire, with No. 4 pin wire at the top. There were telegraph wires $\frac{1}{2}$ mile long, and wires suitable for a Brooklyn Bridge, and from this to weaving wire in a piece 38.7 miles long and weighing only 66 pounds.

Besides these were shown the dies each made of a single diamond by which the wires are drawn, one was made from a $\frac{4}{3}$ karat stone for wire 8 hundredths of an inch thick, while another from a little stone $\frac{1}{4}$ of a karat was for drawing wire only 2 ten-thousandths of an inch thin.

Special attention was paid to an exhibit of a mineral industry which has practically begun since the last Exposition at Paris. Strange to say, before that time, we manufactured almost no tin plates, and now the exhibit shows the products from more than a score of large manufactories, and developments which place us in the front rank as regards quantity and especially quality of this useful material. The industry practically began with 11 million pounds of plates in 1891, and extended to 907 million pounds in 1899.

The Crescent Steel Company's exhibit gave an interesting

suggestion as to how iron and steel come to be such valuable elements in our general industries.

This firm alone showed materials sent to 125 other industrial concerns to use in the manufacture of their products. There was for example, a steel die furnished for the Gorham Mfg. Company for stamping the handle of a brush, a die which costs finished about \$1,000. Part of this great cost is accounted for by the fact that in its manufacture it was submitted to a pressure of 600 tons applied 27 times, the die being annealed between each operation. What has been accomplished in the manufacture of high grade steel is shown by a die made of this steel for pressing a brass clock dial. This die was used for eight years and made 1,344,000 dials. Another similar die had furnished 1,920,000 stampings.

Another die for rolling screws had produced 600,000 without even being re-dressed, another 1500 gross of spoons; and finally a tool for pointing pins had continued in use after it had been annealed and rehardened about 20 times and had pointed fully 120,000,000 of pins. Another piece of similar steel had been hardened 550 times and was still sufficiently hard to scratch glass.

Naturally, in a country like our own, it is the exhibits of the minerals themselves which attract most attention. Interest was centered upon a case of gold, in which the central piece alone, probably the finest specimen of native gold ever taken from the earth, had a bullion value of more than \$3,000. This was supplemented by stores of gold nuggets and crystalline gold from all parts of the West, and even from the old producing localities of North Carolina and the East.

Arranged around this central exhibit of native gold were cases, one of which contained a native nugget of pure silver, worth in silver over \$3,000.

With this was a wonderful showing of the copper from Lake Superior, and the beautiful copper ores, azurite and malachite, from the Copper Queen mines of Arizona.

More wonderful still were the wonderful telluride ores from the Cripple Creek mines of Colorado, and these were supplemented by other ores of precious metals so that the visitor could become familiar with these products in all their various forms.

Some idea of the enormous work involved in collecting such an exhibit can be gained from the systematic mineral collection showing practically all the kinds of minerals found in the United States, and aggregating about 400 specimens.

A library of mining, metallurgical, mineralogical and geological information was installed in a convenient reading room, especially dedicated to the use of the American Institute of Mining Engineers, and on reaching the other end of the exhibit one found a collective exhibit made by the United States Geological Survey for the Standard Oil Company, and containing a complete exposition of the petroleum industry.

There is not time to describe in detail what can be done to illustrate optically to a visitor the various features of this manifold industry, but the exhibit comprised a collection of all the different kinds of petroleum characteristic of the United States in the condition in which it comes from the earth.

The geological conditions of this occurrence were also shown, and even the petroleum regions themselves were well illustrated by oil paintings surrounding the entire exhibit, from the crude petroleum itself. The ramifications into all manner of finished products satisfied the utmost needs of the petroleum technologist, and led to an endless variety of special products, candles, vasoline derivatives and the uses of petroleum in medicine.

What has been mentioned shows the variety of products necessary to illustrate the mineral resources of the United States; and, in addition, the collective exhibits of clays, building stones, and iron ores aggregated hundreds of individual specimens.

But most interesting of all undoubtedly was the case showing the variety of precious stones produced in the United States. It was collected by Mr. George F. Kunz, for presentation to the American Museum of Natural History, New York. The case itself contained perhaps $\frac{1}{10}$ of one year's product in this interesting line of mineral industry.

It called attention to the great variety and color of the sapphires now being mined in considerable quantities by an English syndicate in Montana, and after showing a good series of diamonds which have been found in California, and latterly in Wisconsin, it gave an excellent illustration of the variety of gem materials, including amethyst, cairngorm stones, quartz topaz, and many other gems furnished by the mineral quartz in its various forms and colors. And most interesting of all was, perhaps, a meteorite which has not only been shown to contain diamonds, but diamond dust itself has been extracted from this meteorite, and with it, with its actual character well shown by polishing, another diamond.

There is another feature of most special value to mankind developed by this Exposition, the use made of all this exhibit material by making the Exposition the place of gathering for various congresses, particularly on mining and metallurgy and the

Biennial International Geological Congress, and the newly organized International Congress for the consideration of the single subject of Petroleum in its various phases.

One can easily imagine the value of such collections of exhibits in connection with the discussions of such congresses, and by their appreciation comes some reward for the untiring efforts of the various experts whose time and energy, and particularly whose original thoughts, brought these great collections into their place. It is evident that the work so successfully carried on at Paris is to be continued in the United States in the Expositions to be held here for the next two or three years.

We can safely say that at the Paris Exposition the resources and industries of the United States were plentifully capable of contributing their proper share to all the benefits which can be derived; but I must answer, in so far as I can, one question which is always asked when this great exhibition of the close of the century is mentioned—"How did it compare with our own Exhibition at Chicago?"

A more difficult question to answer is hard to conceive, on account of the different conditions under which the two exhibitions were made. Considering the cramped space at command, one cannot too highly praise the excellence of the detailed exhibits, the thought bestowed upon them, the effort to show the evolution of various industries and arts; the retrospective exhibits of the French themselves reflected the great study and care in making these exhibits as complete and instructive as could be. It is doubtful whether as complete an exhibit of the World's resources, products and arts will ever be made again, the tendency must be made towards expositions more special in their character, and we can go a step backward and say that from the point of view of showing great advances and great creations, the Exposition at Chicago never has been and probably never will be equalled.

Serpentine Marbles of Washington.

Written for MINES AND MINERALS by Prof. D. A. Lyon.

Among the many mineral deposits of Washington, not at all the least valuable are those of serpentine. Especially is this true of a deposit which has been recently opened up which is situated eight and one-eighth miles west of Valley, a siding on the Spokane Falls and Northern Railroad, and about sixty miles north of the city of Spokane, and which is the property of the United States Marble Company. Although the deposit was discovered some time ago, yet it has practically been developed within the last three years, until now it is one of the state's best enterprises.

The discovery of this deposit was made by Thomas H. Greenway, an English marble expert who is at present superintendent of the quarry for the company which is operating it. His attention was first called to these deposits by being shown some samples of greenish looking stone which an Indian had given to a friend of his. He at once recognized in them a valuable stone and immediately set out to locate the original deposit. He soon learned that the samples he had seen had come from what is known as "Huckleberry Range" in Stevens county. Although he found that the property had already been located, he was able to obtain an interest in a deposit in a valley near the foot of the mountain where the present quarry is. On development it was discovered that this was only an overthrow, or slide, and so Mr. Greenway set about to locate the source of the deposit. It was three years before he was successful, and then by an extreme bit of good fortune he discovered the outcrop of this great dyke, which he says was not more than ten (10) feet square and on the sheer face of a perpendicular cliff. He had often passed over this cliff, but had never thought it was valuable or that it concealed the object of his search. One day he noticed this particular outcrop, and with a few blows of his pick soon found that he had at last come upon what he had been looking for. Although he had been successful in his search, he found that his task was by no means ended, for money was needed to develop the property, and it was hard to interest those who had it in something which they could not appreciate the value of, and which to most people was a very tame and uncertain venture, especially as compared with a gold or copper mine. Nevertheless, Mr. Greenway held on to his property, and finally in 1897 he brought to the Spokane exposition samples of beautifully carved work in this green marble. These attracted the attention of eastern men who were visiting the city and as a result a company was organized and the property exploited.

The company has built a splendid wagon-road from Valley station to the quarry, and as the latter is situated some two thousand feet higher than the station, the transportation of the marble is quite easy.

The deposit appears as a great dyke. The present development has exposed a body of solid serpentine over 300 feet in width and 250 feet in depth. As the foot wall stands erect and

the hanging wall has not been seen in its contact with the serpentine, the dip of the deposit has not been determined. It is thought that the dyke stands on an angle of about 45 degrees and that it is dipping directly toward the very heart of the mountain. This is judged by the grain of the rock which shows this inclination. It is said that the deposit may be traced along the bench of the mountain by occasional babbings through the cap rock and by the analagous appearance of the cap for fully fifteen hundred feet when a sharp precipice is reached. At the bottom of this precipice, down a narrow canyon and one thousand feet lower than the quarry floor the deposit again crops out and here it is found to be of just as beautiful a color and of the same quality as where it is now being worked.

The foot wall is a heavy crystallized black marble with white markings. This of itself is a beautiful stone and also quite valuable. It is thought by those who have examined this deposit that the marble is older than the serpentine, that the latter is an eruptive rock and that when it was thrown up it tilted the black marble back on its end. Some of it was displaced to such an extent that it fell over into the canyon below partly filling the latter. A part of this break over forms a great gorge with perpendicular walls and in the bottom of this the shell of black marble is so thin that the serpentine crops through it. Here are some spiral caves of much beauty, which are thought to be either fire holes or are caused by the volcanic disturbance of the rocks at the time the serpentine made its appearance.

The hanging wall is a slate. Apparently it was thrown back in the opposite direction when the black marble was thrown into a vertical position by the eruptive serpentine. It is a fine, silver gray slate, very tough, very solid and very desirable for building purposes. The company operating this property occupies the rare position of owning a property of great value in itself and with both of its walls of value also. This slate is of vast extent, requiring six mineral claims to cover it.

The capping over the dike is a black marble which has been transformed by extreme heat so that it is much faded. About two hundred feet back from the face of the quarry is the remnant of a dike of porphyry which leans against the black marble. The other part of the dike seems to have been tipped over into the canyon at the time the serpentine was erupted.

In the gulch below the quarry the country for more than a mile is cut by a large porphyry dike. In building a road up to the quarry it was necessary to break into this dike, when it was found that there was every indication of an abundance of iron ore and many fine indications of copper. Perhaps some day the company may turn its attention to the working of these ores, but just at present, as Mr. Mitchell the manager expressed, they are "too busy to monkey with them."

The slate is cut off at the north by a huge dike of quartzite which also shows many indications of mineralization. This dike cuts the slate formation about at right angles.

Running parallel to the large dike on the hill and apparently an offshoot from it is another vein of serpentine. It is of a rare green, banded in its colors and where it crops out it is perfectly solid. As no work has been done on it, its extent and value have not been determined.

From various analyses which have been made on this serpentine its average composition is found to be as follows:

Magnesia	54.28
Silica	13.25
Iron Oxide	1.86
Alumina	2.90
Lime carb.	1.70
Loss in ignition, water, and carbon dioxide	26.80
	99.79.

Antimony.

Antimony is chiefly valuable as an alloy with other metals. It is used to large extent with lead in the manufacture of type metal, to which it gives hardness, and what is more valuable, it possesses the peculiarity, when used as an alloy, of expanding at the moment of solidifying, thus giving to the type a clean, sharp impression. From 10 to 16 parts of antimony in 100 are used in making britannia metal. Pewter contains about 7 per cent. It is used in the manufacture of babbitt metal, an antifriction alloy used in the journals of railroad locomotives and cars and other rapidly moving machinery. It has lately been used as alloy with aluminum, to which it gives hardness and elasticity. Its effect on some metals is very injurious, particularly copper, an almost inappreciable amount (one part in a thousand) destroying its good qualities. The well-known medicinal preparation, tartar emetic, is a tartrate of antimony and potassium. The trisulphide is also used to some extent in medical practice. The sulphide was used to considerable extent by the ancients as a pigment, and women of the East are said to use it at the present day for darkening their eyebrows.

GOLD DREDGING

In New Zealand—A Description of the Dredges and the Methods of Working Thick Beds of Wash on the Molyneux River.

By A. C. Perkins.*

The principal centre of Gold Dredging operations in New Zealand has been the Molyneux River, with its main tributary the Kawarau.

The first dredging operations were carried out on the Kawarau River near Cromwell, in 1863. The dredge was of the old spoon type. This proved so successful that it was soon followed by numerous other dredges of a similar design, and by this means many of the smoother portions of the river were worked and very large quantities of gold were obtained. The deposits upon which the old spoons worked consisted of layers of "virgin" wash from a few inches to three or four feet in depth, but since that time the bed of the river has been filled up with tailings which have been sluiced in all along the banks for many miles; the result is, that in order to get at the wash upon which the spoon dredges worked with comparative ease, the bucket dredges now in operation have to lift from twenty to forty feet of barren gravel, and not only this, there are now so many dredges working in the river and into the banks, all discharging their tailings into the stream, that with the exception of a few months in the winter when the river is low there is a continuous flow of drift which greatly impedes the progress of any dredge in contact with it. Yet in face of all these difficulties and dead work, the modern bucket dredge proves a success. I relate this to show that dredging in New Zealand is not all plain sailing, and that upon the Molyneux the proportion of wash to the bulk of material treated is very small.

The old spoon dredge was a very primitive arrangement, it consisted simply of a scoop on the end of a long handle to which was attached a cow-hide bag for holding the wash, which was worked from a small barge entirely by hand power. The operation was very slow and laborious and one or two tons per hour was good work.

After the great Molyneux flood of 1878 the spoon dredges were no longer of any service, and many other contrivances were tried with a view to working the bed of the river. Among these was one of Welman's Centrifugal Dredging Pumps. It was set to work on the Manuherikia at its junction with the Molyneux, but as these machines are in no way adapted for breaking up tightly set ground or dealing with large stones, it was not a success. Centrifugal dredges have also been tried at Waipapa and various other places, but so far as New Zealand is concerned they have not been a success.

Current Wheel Dredges.—These were the earliest form of bucket dredge in use on the Molyneux, and as far back as the early seventies were successful gold winners. They were run at a very low cost, three or four ounces per week would defray expenses.

The First Steam Bucket Dredges were built in 1881 and were set to work on the Molyneux just above Alexandra, these were the Eureka (recently dismantled) and the Dunedin dredge which is still at work near Roxborough. The history of the latter dredge is not without interest. It worked for some time in a basin of the river near where it was built, and got returns as high as eighty ounces in a week; but as the system in vogue at that time was to strike a lead, and then try to follow it, a great deal of time was wasted in moving from one place to another, with the result that only partial success was achieved, and ultimately this ground was abandoned and the dredge floated some thirty miles down the river, in which locality it is still.

As illustrative of the improvements which have been made in dredges, and in methods of working them since their introduction, it is a note-worthy fact that at the present time there are no less than six dredges working the ground abandoned by the Dunedin, and all getting good returns.

The modern bucket gold dredger consists of a barge upon which is placed the whole of the machinery and plant, consisting of engines, boiler, dredging apparatus, centrifugal pumps for lifting water, revolving perforated screen, gold-saving appliance, elevator for stacking the tailings, and steam winch for working the mooring and ladder lines. The whole plant is self contained, and is adapted for working either the beds of rivers, beaches, or into high banks where there is sufficient water to float the dredge properly clear of the bottom; or in flats away from any water course, provided the necessary water for floating and washing purposes is available. The hull is usually built of wood, owing to the present high price of steel, but the latter material is undoubtedly preferable. It is constructed with an open well in the centre from the bow about two-thirds of the entire length to allow of the ladder passing down. The ladder is usually constructed of

steel, and the length is determined from the depth of the ground below water level to be operated upon; thus for shallow ground thirty-two feet would be ample length, whereas there are seventy-five to eighty feet ladders in use, dredging over fifty feet below water. It is supported at the upper end on a pivoting shaft, and at the lower end is hung with a steel wire line running in sheave blocks. The buckets are coupled together with connecting links and pins, forming an endless belt which travels over the driving tumbler at the upper end and round the lower tumbler at the bottom end of the ladder, on the same principle as that employed on harbor dredges. There are usually two or three grab hooks in the bucket belt for loosening the wash, and lifting stones.

The power from the engines is transmitted through various mediums. In some cases direct gearing is employed, but usually belting or ropes are used with intermediate gear. Attached to the gear is a friction clutch, by means of which the buckets may be thrown in or out of action, without interfering with the engine. This clutch also works automatically in case of any serious obstruction coming in the way of the buckets, and thus many a serious break down is prevented.

The wash dirt from the buckets is discharged into a chute, thence into the revolving perforated screen; while passing through this screen it is continually under a continuous spray of water, which washes the smaller particles with the gold through the perforations onto the gold saving tables. The rougher gravel or tailings is discharged from the screen into the elevator trays, and by this means is carried up, and deposited on the tailings heap some distance astern of the dredge.

The elevator is worked on the same principle as the main buckets. The longest elevators at present in use will stack tailings to about fifty feet above water level.

The gold saving appliance consists of a spread of tables from twelve to eighteen feet in width, with a run of twelve to sixteen feet over ripples of various kinds and coconut matting, etc. There are also various appliances for intercepting nuggets. The silt after passing over the tables is carried astern with a chute, but in the case of very large deposits, provision is made for elevating it with the tailings.

The dredge is moored with five steel lines, which are attached to backer logs sunk into the ground at a convenient distance from the dredge, and to the winch, each line having a separate barrel, by means of these the dredge is easily moved to any required position.

Working Ground.—In commencing operations, the buckets being in motion are gradually lowered into the wash, until the bottom is reached; from this a paddock is opened out, say fifty yards, or to any required width, by working over on the side lines with the head line as radius, the dredge is then pulled two or three feet forward on the head line and worked back to the point from which it started; this operation is repeated, and the buckets kept scraping the bottom all the way across. By adopting this method the ground is systematically worked. Everything is taken in a face, and when the dredge has worked forward its own length, the tailings are deposited in the paddock which has been cleaned up. A dredge putting through one hundred and twenty yards per hour is easily worked by two men, and the horse-power required, if under favorable conditions, is forty-five to fifty actual.

Quantity of Material Treated and Cost per Cubic Yard.—A great deal depends upon the nature of the deposits, as well as the class of dredge in use as to the results obtained under this head. For instance: With a comparatively free gravel deposit of twelve or more feet in depth, and not less than ten feet below water, lying on a soft bottom, a four-and-a-half cubic feet bucket dredge might reasonably be expected to work up to seven-eighths of its maximum capacity. Taking the maximum at one hundred and twenty yards per hour, this would give one hundred and five yards per hour, and with one hundred and thirty hours actual dredging time per week we have a total of thirteen thousand six hundred and fifty cubic yards for a week's work. Taking the working expenses of a dredge, including everything, at £45 (\$219) per week, this works out to just four-fifths of a penny (1.6 cents) per cubic yard. I may say that I have obtained results equal to the above in actual practice on the Molyneux. I also had to deal with ground where the conditions were anything but favorable, the deposit was about twenty-five feet in depth, the bottom thirty-five feet below water, a layer of wash five to ten feet thick lay on an uneven, rutty, clay bottom; this bottom wash consisted of rough boulders from the size of a football up to four or five tons in weight, all very tightly packed and set together with small gravel. Of course this ground was very difficult to work, and a first-class dredge of the former capacity could get through only one-fifth or one-sixth of the former quantity, about two thousand five hundred yards per week at a cost of about fourpence (8 cents) per yard. This may seem a very small quantity, but in deposits of this kind it is in digging up the stuff where the work lies, and it is a very much better result than could be obtained with any other class of dredge under

* A paper read at the September, 1900, meeting of the New South Wales Chamber of Mines.

similar circumstances. To give some idea of the varying and excessive strain the machinery is subject to in ground of this kind, successive diagrams taken from the engine showed the horse-power to vary from forty-five to seventy in three revolutions.

In shallow ground where the deposits are only a few feet in depth, there is great difficulty in getting the buckets full as the dredge has to be kept continually on the move and, unless the deposit is of a very free nature, the average obtained in practice will not much exceed one third of the maximum capacity of the dredge. As a rule the best average can be made in large and deep deposits when there is no scarcity of material to operate upon. The results obtained from any dredge must depend on the class of ground, the suitability of the dredge, and the capabilities of the winchmen. These are most important points which cannot be safely lost sight of in forming estimates.

The special feature of the bucket dredge as a miner are these: It combines large and economical lifting capacity with the power to dig up rough and hard deposits, it is capable of lifting large stones, and if boulders are met with too large to lift, they can be rolled out of the way by means of the buckets. The bottom, unless of a rough rocky nature, is thoroughly cleaned, and the whole material is lifted, treated, and deposited clear of the dredge in one operation, without any handling, and as only two men are required to work the whole thing, it is certainly a most up-to-date labor saving appliance.

The earlier dredges were small. Their buckets usually having a capacity of one to two cubic feet, and the operations were confined almost exclusively to the river bed, but as it became gradually filled up and operations were carried into the beaches, it was found necessary to get through more stuff in order to make it pay, and buckets of two-and-a-half to three-and-a-half cubic feet were brought into use. With the introduction of the elevator which was to facilitate the working of low beaches, the idea of getting into the banks originated, and with it the further necessity of getting through more stuff. This of course meant larger buckets and longer elevators. The Molyneux Hydraulic Company's dredge, designed by Mr. E. Roberts, of Dunedin, was one of the first of this description with buckets of four-and-a-half cubic feet capacity, and an elevator of about seventy-five feet in length. The career of this company is not without interest, proving as it did the superiority of dredging over hydraulic elevating. The company was formed to work a bank claim by hydraulic sluicing, they had a large body of water brought on by gravitation, with a good pressure and a free get away for their tailings, which were run into the river. The project, however, was not a success, and as a last resource to prevent liquidation, they decided to put on a large dredge. In order to raise capital for this purpose, a fresh issue of shares had to be made. This was done, the dredge was built, and the result today is that the shareholders, both of the original and latter issue, receive dividends from their property. The immediate result of this was, that the Golden Beach Company on the opposite side of the river, also working a large hydraulic elevating plant, followed suite with equally satisfactory results.

The success of these, and other similar dredges, has suggested the idea of working the whole of the extensive Molyneux Flats but the first difficulty confronting the engineer is the fact that the top of these flats is from forty to sixty feet above the level of the river; while the bottom is twenty to thirty feet below water, making a face of seventy to ninety feet in depth, all of solid gravel. However, there are several dredges now in course of construction, to work some of this ground. Notably among these are the "Glasgow," the "Dunstan Lead" and "Fraser Flat," designed by Mr. F. W. Payne, of Dunedin. They each have seven cubic feet buckets, with a capacity of twenty-two thousand cubic yards per week.

The elevator of the Fraser Flat is the largest yet constructed, it is one hundred and forty-five feet in length, and when complete will stack the tailings together with the silt eighty feet above water level.

The present cost of a plant of this description is something like £14,000 (\$68,180).

The Kawarau Dredges have had difficulty in dredging deep enough to reach the wash which in places is fifty feet below water level. The Lady Ranfurly, also designed by Mr. F. W. Payne, is a fair specimen of the class of dredge required for this work. Its chief dimensions are as follows: Hull; length, one hundred and ten feet; beam, thirty feet; depth, seven feet six inches; length of ladder, seventy-five feet centers, buckets of six cubic feet capacity. It can dredge fifty-two feet below water level, and with the record return of one thousand two hundred and thirty-four ounces for one week, has put all others in the shade.

In addition to the Molyneux, there are numerous other fields such as Wiapori, Glenore, Manuhierikia, Waikaka, Waimumu, the Nevis, and various places on the west coast. All of these, with others not mentioned, are yielding highly payable returns,

and the industry from the standpoint of results never looked brighter than at the present time.

In conclusion, comparing the dredging fields of New South Wales with those of New Zealand, I may say that I have seen a great many of the dredging areas in this country, and, although speaking generally, the deposits in the Molyneux Flats are much more extensive, with room for larger operations than the greater part of the dredging ground in this Colony, there is quite as good dredging ground in New South Wales as anywhere in New Zealand, and many of the prospects point to the probability, when the industry gets fairly going, of returns which will compare very favorably with New Zealand. In fact I am decidedly of the opinion that there is a great future for dredge mining in this Colony.

Naphtha Safety Lamp With Magnetic Locking Device.

The American Safety Lamp Company, of Scranton, Pa., has recently put on the market a new safety lamp, which it is thought combines many of the good qualities of a number of

other lamps at present on the market, the distinguishing feature being a very simple magnetic unlocking device. The accompanying illustration shows the novel features of this lamp for which an application for patent is now pending.

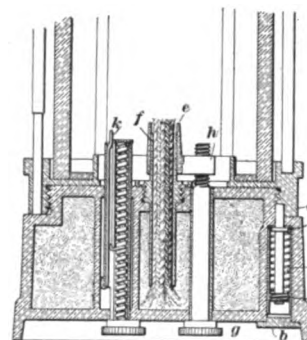


FIG. 1.

The locking device consists of a pin, *a*, which fits into the locking thread of the lamp and prevents it from being opened unless the pin is drawn down through contact between the copper plate, *b*, on the base of the lamp and a magnet *m* on the unlocking device, Fig. 2. There are several grooves in the threaded portion of the upper part of the lamp, so that even if the pin is drawn out of the first groove the lamp can only be opened through a part of one turn before the pin slips into a second groove. Three of these grooves are at present fitted in the lamp, but should it become advisable to do so their number may be increased almost indefinitely and the safety of the lamp thus added to. The pin is held in place by the spring *c* placed between a shoulder *s* on the pin and a plate *p*.

The device for opening the lamp is shown in Fig. 2. *m* is the top of a piece of soft iron wound with wire, which wire is connected with four dry batteries placed in the box beneath the switch *k*. When the switch is connected up, the current passing through the wire converts the iron core into a magnet, and when the base of the lamp is placed upon this so that the copper plate *b* is in contact with the top of the magnet *m*, the pin *a* is drawn down and the threads of the lamp thus released. The cost of the unlocking device is very small, as can be seen, as the only thing that can wear out is the dry batteries, which can each be replaced for the small sum of 15 cents, or less.

The lamp is lighted by means of an automatic igniter *k*, Fig. 1. To regulate the height of the flame the lamp is provided with a cap *e*, which fits over the wick tube *f*. This cap is lowered by means of a screw *g*, working in the threaded portion of the cap *h*. The wick tube *f* screws into the upper part of the oil chamber and thus forms a close joint. The base is filled with absorbent cotton which takes up the naphtha. The lamp is perfectly clean, as only so much naphtha is supposed to be added as will be taken up by this absorbent cotton, and there should be no excess which can leak out in any way. The lamp is very sensitive to gas and will go out in an excess of gas.

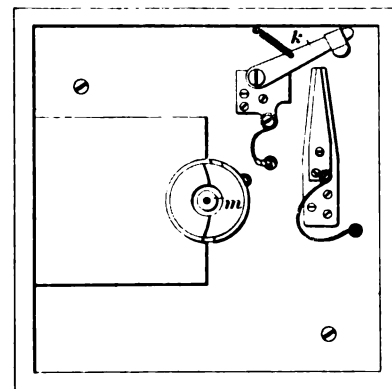


FIG. 2.

The unit of light, or a standard candle power, is the light given out by a sperm candle, weighing six to the pound and burning 120 grains per hour.

GRAPHITE AND GARNET

Industries in Pennsylvania—Where the Minerals Occur—The Uses to Which They Are Put, and Their Values.

Written for MINES AND MINERALS, by T. C. Hopkins.

The southeastern counties of Pennsylvania are greatly favored by Nature; in addition to a genial climate and a rich soil there is a great variety of mineral products of both economic and scientific value. Many of the products having economic importance have been described with more or less detail in the State and National Geological Survey reports but graphite and garnets are two of which almost nothing has been published hence the present article.

Graphite, plumbago, or black lead is an iron-black to steel-gray, soft mineral, with a greasy feel and metallic, sometimes earthy, luster. It crystallizes in the rhombohedral system in six-sided tabular crystals and occurs in foliated masses, columnar or radiated, scaly, slaty, granular or earthy. It is nearly pure carbon, unaffected by acids and capable of withstanding very high temperatures. It resembles molybdenite in softness and structure but is readily distinguished by its being unaffected by acids and heat.

The principal uses of the high grade graphite are in lead pencils and as a lubricant, in which it appears to be growing in favor especially for the bearings of high speed engines and heavy machinery. Large quantities are used in the manufacture of crucibles, particularly in certain branches of the steel industry. Foundry facings, stove polish and graphite paint take large quantities of the cruder product. It has an increasing usage as a paint for coating smokestacks, boilers, tin roofs, and all metallic surfaces exposed to the weather; because of its power to protect the metallic surface from rust or oxidation. The proportionate amount of graphite used for different purposes is estimated by Davies as follows: (1) Crucibles and refractory articles, 35%; (2) stove polish, 32%; (3) lubricating graphite, 10%; (4) foundry facings, etc., 8%; (5) graphite greases, 6%; pencil leads, 3%; (7) graphite packing, 3%; (8) polishing shot and powder, 2%; (9) paint, $\frac{1}{2}$ %; (10) electrotyping, $\frac{1}{2}$ %; (11) miscellaneous—piano action, photographers', gilders', and hatters' use, electrical supplies, etc., $\frac{1}{2}$ %. This estimate was made 20 years ago and there will be considerable variation now. Nos. 9 and 10 will have greatly increased at the expense of No. 2.

The price varies considerably from year to year. Thus in 1898 there was advance of more than 50%. Dust graphite that sold for 1.4 cents per pound at the beginning of the year was quoted at 3 cents at the end of the year, while chips advanced from 2c.-3c. to $\frac{1}{2}$ ¢ to 6c. per pound and lump graphite from 3 5c. to 7.5c.-9c.

Graphite is widely distributed in gneiss, mica schist, granite, and limestone rocks but in not many places does it occur in commercial quantities. It is a common furnace product in small quantities, and it occurs in meteoric and foundry iron. The most productive locality in the United States is at Ticonderoga in New York, which mines are controlled by the Jos. Dixon Crucible Company. There are several productive mines in Chester and Berks counties, Pennsylvania, and a small quantity (about 60 tons) was produced in Clay county, Alabama, in 1899. Graphite is known to occur and has been produced in limited quantities, although the mines are not producing at present, in Michigan; Rhode Island (graphitic coal); New Hampshire; New Jersey; Black Hills, Dakota; Wyoming; Utah; Nevada; California; and Texas.

Of the foreign localities the island of Ceylon is one of the most famed for both the quality and quantity of the graphite produced. The mining is done by hand by the natives entirely and there is no attempt to improve on the crude methods in use since the mines were first opened. About half the Ceylon product is shipped to the United States, the other half to Europe.

One of the famous graphite mines of the world is that at Passau, Germany, which has been producing for several hundred years and the supply is not yet exhausted. Austria is the largest producer in the world at present, but previous to 1893 Ceylon was the most productive. Other producing countries are Italy, Russia, Japan, Canada, England and Wales.

Graphite is mined in Pennsylvania in three different localities and at several other points it has been mined for longer or shorter periods.

The Philadelphia Graphite Company opened a mine and erected a refining plant a mile east of Chester Springs, Chester County, in the summer of 1897, since which date it has been an active producer. The production is at the rate of about two tons per day. The mineral occurs in two "veins" or layers, one about 4 feet, the other about 6 feet thick, both in disintegrated mica schist. The veins, so-called, are simply layers of the mica schist which are richly impregnated with graphite. The rock is so much disintegrated that most of the graphitic material can be removed with the pick and shovel without blasting. Drifts are run in on the hillside following the graphitic layer. The material is loaded

on the mine cars in the drift and the cars then pushed to the refining mill at the mouth of the mine, where it is crushed in rolls and cleaned in a washer similar in principle to the common log washer used at the clay works. After washing it is again ground and further refined by means of air currents and separated into several different grades.

At Byre station, at the end of the Pickering Valley Railroad, several miles below Chester Springs, graphite has been mined in considerable quantities for a number of years. It is a lower grade than that mentioned above and is not refined so carefully. It is shipped to Reading and Bethlehem where it is used for foundry facings. The graphite works at Byre were destroyed by fire a few months ago.

There is an abandoned graphite mine and refining plant at Pikeland, Chester county, which was productive a few years ago.

At Boyertown in eastern Berks County a graphite mine was opened many years ago and some crude graphite shipped but the industry apparently proved unprofitable and was soon abandoned. In the summer of 1899 the Boyertown Graphite Co. reopened the mine and erected a refining mill where the graphite is separated and prepared for market. It occurs here in a partially disintegrated mica schist in which a shaft has been sunk to a depth of 50 ft., through which the ore mined in underground galleries is elevated to the surface and transferred by wheelbarrow to the crusher. The industry is still in the experimental stage, but promises to be a financial success.

Near Mertztown, in northern Berks County, the Penn Graphite Company (of Allentown) operates a productive graphite mine and well-equipped refining mill. The mine has been operated at intervals for 20 years by different parties, but since the present company took possession in 1897 it has been in continuous operation and worked more systematically than formerly. It is now producing about 2 tons per day—one and a half tons of flake graphite and a half ton of lower grade used for graphite paint. The sand which is a by-product from the refining process, is sold to the foundries for moulding sand. The graphite occurs in a lenticular vein in a coarse-grained sandstone. The maximum thickness of the lens or vein is 3½ feet and 28 per cent. of the vein material is graphite. It is mined with pick and shovel in galleries at different levels and elevated to the surface by horsepower. The material is then crushed, washed and further refined by air currents and then packed for shipment.

Graphite occurs at other points in Pennsylvania, but so far as known has not been produced commercially except at the points above named.

Garnets occur in large numbers in the mica schists in many localities in the southeastern counties of Pennsylvania but in only one locality are they mined in commercial quantities. Near Chelsea in Delaware county are two garnet quarries both owned by a Brooklyn party, but one has been leased to, and is operated by, another party; the product of both quarries is shipped to the factory of the owner in Brooklyn. The garnets are the common iron garnet, and occur impregnating the mica schist making approximately 75 per cent. of the whole mass in the richer portions. The individual garnets vary in size from those an inch or more down to those a sixteenth of an inch or less in diameter. There are no perfect crystals, although the general form or outline of the crystal is generally shown. The corners are rounded and the crystals elongated, flattened or otherwise distorted. In the weathered portions of the mother rock, the crystals can be very easily separated from the inclosing material, but in the fresh rock they are so firmly imbedded that it is impossible to remove them from the rock without fracturing them.

One of the quarries is operated in open cuts, the other in underground drifts. The upper portion of the rock is so much disintegrated (to a depth of 50' or more) that much of the material can be mined with pick and shovel. The fresher portions require blasting. The material is thrown in the washer which resembles the log washer used for cleaning ore, and the heavier garnets are separated from the lighter rock material by the current of water. After washing, the material is screened into 4 sizes and shipped to the factory where it is further crushed and screened into many different sizes. It is used for making sandpaper or garnet paper which is used extensively as an abrasive in the manufacture of boots and shoes and less extensively in the wood-manufacturing industry. It is found to be sharper and more lasting than quartz sandpaper and is frequently preferred to it although it costs much more. Its superiority over quartz is probably due to its ready cleavage by means of which it constantly renews its sharp cutting edges, where quartz becomes dulled and rounded by friction. It varies from 6.5 to 7.5 in the scale of hardness in which quartz is 7.

Garnet for abrasive use is also quarried in the Adirondack region in Warren county, N. Y. It occurs in many other localities, but is not used except as an ornamental stone. The average price of the garnet is about \$35 or \$40 per ton but the market is so small that there is no fixed price.

OBITUARY.

THOMAS SHAW.

Thos. Shaw, the well-known mechanical engineer and inventor of Philadelphia and Shawmont, died at Hammondtown, Saturday, Jan. 19th, 1901, as the result of a stroke of apoplexy. One month before his death, he started for Atlantic City, in charge of a trained nurse, but was taken seriously ill on the train and was obliged to go to a hotel at Hammondtown, and was never able to continue the journey.

Mr. Shaw was born in Philadelphia, April 5th, 1838, and from an early age showed a decided mechanical and inventive genius. There are drawings in existence, made when he was only eight years of age, showing a distinct and unmistakable mechanical bent. When only twenty-one years of age, he was General Superintendent of the Midvale Steel Works and is said to have been the first man to roll steel tires. His first patent was granted by the United States in 1858 and was for a gas meter. Since that time he has been granted one hundred and eighty-six patents covering ninety-one different subjects in engineering. In 1863, he patented the mercury steam gauge, which is a standard of pressure in most parts of the civilized world. Another notable invention is his nut lock washer of which there are hundreds of millions in use. These nuts are placed between the nut and the fishplate of rails, and hold the nut in place in spite of vibrations.

Mr. Shaw was in business in Philadelphia, for more than thirty years at No. 915 Ridge Avenue, and has left over two hundred unpatented inventions with drawings and descriptions. He was awarded more than one hundred medals by different expositions and societies, and received the Elliott-Cresson Gold Medal and two Scott-Legacy Medals, which are the highest awards in the gift of the Franklin Institute of Philadelphia.

The invention by which Mr. Shaw is probably best known to mining men is the Shaw Gas Tester, which is a marvel of mechanical ingenuity. By means of it the percentage of marsh gas in the



THOMAS SHAW.

atmosphere of a mine, can be determined with a degree of accuracy far within any limits required for practical work. This gas tester is in use in a large number of the coal districts of the United States and in a number of foreign countries.

Mr. Shaw was a Life Member of the American Institute of Mining Engineers, of the Franklin Institute, The American Railway Association of the United States, the Philadelphia Board of Trade, Philadelphia Trades League and the American Association of Inventors and Manufacturers, and was a high Mason.

HON. JOHN LEISENRING.

Hon. John Leisenring, the well-known mine owner and anthracite coal operator of Upper Lehigh, Luzerne county, and former congressman from the Luzerne district, died at the University hospital, Philadelphia, Sunday, January 19, 1901.

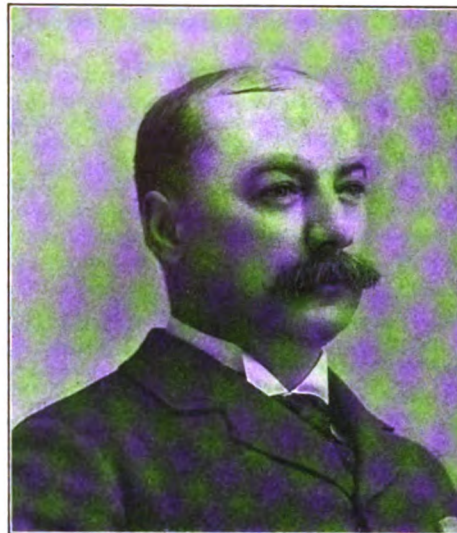
He had been a sufferer for a long time from heart and kidney trouble, and in the latter part of December was taken from his home to the University hospital, in hope that he could obtain relief.

He was born at Ashton, now Lansford, Carbon County, Pennsylvania, June 3, 1853. He was educated at Schwartz's academy, Bethlehem, Pa., and at Merchantville and Princeton, N. J. He was by profession a civil and mining engineer, and had been identified during his entire lifetime with the coal mining

business. He was married to Miss May Simpson, of Mauch Chunk. Mr. and Mrs. Leisenring never had any children.

Mr. Leisenring was elected to the Fifty-fourth congress as a Republican from the Twelfth Pennsylvania (Luzerne county) district. This was the only political office he ever held.

He was president of the Upper Lehigh Coal Company and a director of the Moosic Mountain, the Mount Jessup, the Silver



HON. JOHN LEISENRING.

Brook and the Midvalley Coal companies. He was interested as a stockholder in the Lehigh Coal and Navigation Company and also in a western gold mine.

T. A. BEDFORD—ROBERT LEWIS.

Messrs. T. A. Bedford and Robert Lewis, both of whom were employed as civil engineers by The Davis Coal & Coke Co., of Thomas, W. Va., were suddenly killed near that place on Monday, Jan. 7th, 1901. Their deaths were due to an accident. They were crossing a railroad bridge on the way to work at Coketon and as they were passing a locomotive which was standing on the bridge, with its cylinder cocks open, they were enveloped in steam, and thus did not see an engine approaching on the track upon which they were walking, nor could they be seen by the engineer until the engine was only two feet away. Mr. Lewis was knocked from the bridge falling a distance of 18 feet and striking on his head. Mr. Bedford was caught on the pilot of the engine and dragged along the ties until the engine was stopped when he fell over. Both were picked up unconscious and died within a few hours, after the sad accident.

RALPH DUPEE LACOE.

Mr. Ralph Dupee Lacoe, who died recently at his home in West Pittston, was born November, 1824. He was the son of Anthony Lacoe, who came to the United States from France, and he spent the early years of his life as a carpenter, but became interested in real estate at the time when the coal business was first opening in the vicinity of Pittston. For several years he engaged in the powder business and was at one time cashier of what is now the First National Bank of Pittston. About 36 years ago he retired from active business life on account of ill health, and it is probable that this retirement has been a great advantage to the scientific world, as Mr. Lacoe became a great student of geology, and his collections of coal flora and fossil insects have a world-wide reputation.

Lake Superior Mining Institute.

The secretary of the Lake Superior Mining Institute has issued the following notice:

The seventh meeting of the Lake Superior Mining Institute will be held in the "Copper Country" with headquarters at Houghton, Michigan, March 5, 6, 7, and 8, 1901. Members desiring to present papers at this meeting will please notify the secretary and give title of paper. Vol. VI has been sent to all members not in arrears for dues. If this has not been received, please notify the undersigned,
Houghton, Michigan.
F. W. SPERR,
Secretary.

The Vajen-Bader Co., manufacturers of Vajen's new improved head protector, etc., has moved its offices from the Library Building, Indianapolis, Ind., to Rooms 5-11 Vajen Building, same city.

Mines and Minerals

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The date after your name on the wrapper of MINES AND MINERALS is that of the month to which your subscription has been paid, and if you do not want to continue your subscription after that time, you should notify us, as MINES AND MINERALS will be sent until we receive an explicit order for its discontinuance. The courts have decided that subscribers to newspapers who do not order their paper discontinued at the expiration of the time for which it has been paid, are held liable for the payment of their subscriptions up to the date when they order the paper discontinued.

A subscriber wishing to have his address changed, should be careful to give his former as well as his present address; otherwise we cannot find his name on our mailing list.

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A DEPARTMENT OF MINES FOR PENNSYLVANIA.

BILL No. 84 of the House of Representatives of Pennsylvania State Legislature, provides for the establishment of a Department of Mines in the State to replace the present Bureau of Mines, which is one of the Bureaus of the Department of Internal Affairs.

The chief differences between this proposed department and the present bureau are that it makes the Chief of the Bureau, responsible directly to the Governor, instead of to the Secretary of Internal Affairs, and increases the clerical force of the office. The Chief of the bureau can be removed only by the Governor, and in cases of appeal by the Mine Inspectors of the State, if they are removed by the Chief of the Bureau, this appeal goes to the Governor, instead of to the Secretary of Internal Affairs.

By the present law, if the Chief of the Bureau of Mines receives information by petition signed by ten or more miners or one or more operators, setting forth that any of the Mine Inspectors are neglectful, incompetent, or guilty of malfeasance in office, the Chief is required to investigate the matter. The proposed bill requires such a petition to be signed by ten or more miners or three or more operators.

The new law says that "Before the certificate aforesaid shall be granted to mine-foremen, assistant mine-foremen, foremen of first grade and foremen of second grade certificates, each applicant for the same shall pay the sum of \$3.00 to the Chief of the Department of Mines. In the same manner each successful applicant for a certificate of competency as a miner, shall pay the sum of \$1.00. The money so received shall be turned over in due form to the State Treasurer.

The present law provides that the fee shall be for examination \$1.00, for registration of certificate, \$1.00, and for certificate, \$1.00. These provisions are probably intended to be identical, but there is liability of confusion and misconception by the \$3.00 fee being taken to apply simply to a certificate, not being meant to include the \$1.00 for examination and the \$1.00 for registration. With this interpretation, the mine foreman would have to pay \$5.00, before receiving his certificate.

The main difference in the proposed bill is in the number of officials provided for, and the salaries attached thereto. The officials under the proposed Department would be a Chief of the Bureau of Mines, at a salary of \$4,000 per year. An assistant who shall be a mining engineer, at a salary of \$1,500 per annum. Two clerks, one from the anthracite and one from the bituminous district, who shall have some knowledge of mining, each at a salary of \$1,400 per year. One stenographer and typewriter at a salary of \$1,400 and one messenger, who shall have some knowledge of mining, at a salary of \$900 per year.

The present Chief of the Bureau of Mines receives a salary of \$3,000, his assistant a salary of \$1,400 per annum, and a messenger \$300 per annum.

That the mining industry of Pennsylvania is entitled to a voice in the Cabinet of the Governor goes without saying, but the title Secretary of Mines would be more appropriate than Chief of the Bureau of Mines.

It should be made imperative upon the Department to carry on investigations and experiments which will benefit the mining industry of the state. It should also be required to issue Bulletins giving the results of these experiments and treating upon mining practice in the state, as is done by other States which have far less important mining interests than has Pennsylvania.

If this be the intent of the bill now before the Legislature and if it be carried out, the clerical force provided is none too large, but to secure the services of a competent mining engineer as assistant to the chief, the salary must be increased to at least \$2,500 per year. This will permit of the appointment of a young man thoroughly competent to carry on the routine of work in Harrisburg and will permit the Chief of the Bureau to devote his time to field work and an actual oversight of the mining operations of the State. If proper investigations are provided for and suitable

appointments made, the investment of the money proposed can be made a most profitable one for the State, but the scope of the Department must be materially enlarged over the present Bureau.

A NEW HARTSFELD SCHEME.

C. L. HARTSFELD, who for many years has been notorious for his swindling schemes in connection with mining, has been operating for some time past in Durango, Mexico, under the title of D. Campbell Davies and Co.

Some months ago MINES AND MINERALS received an advertisement from the concern over the signature of Mr. D. Campbell Davies, who gave as references well known smelters in the United States and Wales. We corresponded with some of the references given and the answer to our inquiries were satisfactory; hence the advertisement of D. Campbell Davies & Co. was inserted in MINES AND MINERALS.

The following communication, which is self explanatory, has just been called to our attention, through the courtesy of Messrs. Cross, Laughlin & Co., of St. Louis.

CONSULAR SERVICE, U. S. A.

DURANGO, MEXICO, August 21, 1900.

F. TIEDEMANN, Pres.,
The Union Smelter Mfg. Co.,
Room 208, 415 Locust St.,
St. Louis, Mo.

DEAR SIR:—Yours regarding D. Campbell Davies & Co., has been received. There is no such concern as D. Campbell Davies & Co., in existence here. Mr. C. L. Hartsfeld has been conducting his nefarious schemes here for over a year under the style of "The National Ore & Reduction Co." and I presume that, after that length of time, he has concluded that he and his fakes are becoming too well known and he must needs hide his identity under a different firm (?) name. D. Campbell Davies is a subject of Queen Victoria who has for nearly a year been endeavoring to consume the entire tequila production of this part of Mexico, finally losing his mental balance from such efforts. He was taken in charge by the Mexican Authorities, placed in the public hospital here and treated for softening of the brain. It was soon after his release from the hospital that he and Hartsfeld combined forces. The combination however did not last but a few weeks, as I have heard within the last few days that Davies made off to parts unknown taking \$250 of Hartsfeld's funds. As for Mr. Hartsfeld himself, I will say that there is an article in Mexican law providing for the expulsion or banishment from the country of "pernicious foreigners," and I have recently presented a request to the Governor of this State for the application of said provision in Hartsfeld's case. The Governor is now in communication with the federal authorities in Mexico on the subject, as it is a prerogative that can only be exercised by the President of the Republic; I took this last step upon the application of several members of the American colony in Durango.

As for using my name as a director of his company, I will say that he has done this after repeated requests (during nearly a year) from me that he cease from so doing and even threats from me of legal proceedings that have prevented me from trying to get an order from the court to restrain him from using my name.

Respectfully yours,
(Signed) WALTER H. FAULKNER, U. S. Consul.

We regret that MINES AND MINERALS in company with a number of other technical papers has been taken in by Hartsfeld, but we trust this notice will be given the widest possible circulation to offset any harm that may have been done by the advertisement in our columns.

FAKE PROSPECTING INSTRUMENTS.

THE following is a sample of a number of letters recently received by MINES AND MINERALS:—"I recently received circulars from the P. & M. Agency, of Palmyra, Pa. I have thought of buying one of these *Spanish Needles* for locating gold, as it lays in ledges here, but have been advised to write to you for information as to the merits of these needles, as to whether or not they will locate or draw to gold."

The Spanish Needle, to which our correspondent refers, is an instrument which, judging from the illustrations on the circulars issued by this P. & M. Agency, consists of a long slender handle, to which is attached a circular portion in the center of which a small arrow needle is hung. Below this needle and attached to the bottom of the ring holding it, is a metal socket, into which any one of a number of "points" can be inserted. The circular is adroitly worded, so that it does not state directly how to use the needle, nor does it promise in so many words what results can be obtained by its use, but the illustrations unmistakably convey the impression that if the "point" for gold is used, the needle will point downward if the instrument is held above a deposit of gold, while if the "point" for silver is used, a similar action will take place if the instrument is held above a deposit of silver.

Another form of the same instrument is called the "Gold-ometer" and the illustrations show a man using one of these, about as he would a fishing rod, the inference being that by using different "points" or hooks, either gold, or silver, or iron may be located. Still another variation of the same remarkable instrument is called the "New Magic Gold and Silver Chronometer." The illustrations of these three instruments differ slightly, but the essential element of each is evidently in the detachable "points."

It seems scarcely necessary at the beginning of the 20th century to caution persons against being fooled by such manifest frauds, but from the number of inquiries that we have received and from the fact that this P. & M. Agency has been given a favorable rating in the reports of Dun's Commercial Agency, it is evident that it is prospering upon the ignorance and gullibility of a certain class of people. The character of the circulars issued by the P. & M. Agency, should be enough to show any one its character, but if fortune tellers, mind readers, and others of like ilk, find it profitable to advertise their business in reputable daily papers, we cannot be surprised that some should be fooled by such mining fakes. Such catch expressions as "patent applied for," "write for testimonials," or "testimonials will be furnished upon application," "our references are the postmaster and the local bank," do not mean anything. We have written to the postmaster for the standing of this P. & M. Agency, and have failed to receive any reply. We have also directly addressed the P. & M. Agency, asking for references, but in no case has the Agency answered by letter or in any way excepting by circular.

The Mining Department of this P. & M. Agency is evidently only one of many departments of like character. Some of the other specialties advertised are as follows:—"Transparent Playing Cards," which are thus described, "If you want something sensational and rich, send for a pack of them."

"Chicago by night, what to see and how to find it," "Secrets of Life unveiled, or Book of Fate," "Seals, for use in securing lost treasures," "for bringing great fortunes to the wearer," "for causing the wearer to be agreeable and much loved," "for causing any one to obey your wishes," "will make any one appear before you," etc., etc., etc. It is unnecessary to go further, excepting to say that this same concern issues dozens of circulars of like character, and any one who is foolish enough to send \$50 for the Spanish Needle, Goldometer, Chronometer, or whatever other name they may designate this fake by, deserves to be fooled. The less he says about it, the more self-respect will he retain.

THE COAL AND METAL MINERS' POCKETBOOK.

IT IS very gratifying to the publishers and editors of "The Coal and Metal Miners' Pocketbook" to be able to note that within one month after it was published, it was adopted as a textbook at Columbia University, The Ohio State University, Lehigh University, the Pennsylvania State College, The University of Minnesota, The School of Mines of the Iowa Agricultural College, State School of Mines of South Dakota, University of Wyoming, and McGill University, Montreal, Canada.

BOOK REVIEW.

THE TIMES ALMANAC, published by The Philadelphia Times, Philadelphia, Pa.

PUBLIC LEDGER ALMANAC, published by The Public Ledger, Philadelphia, Pa.

COAL TRADE FOR 1899 AND 1900, by F. E. Seward, Editor of the Coal Trade Journal, N. Y. City.

OIL AND GAS YIELDING FORMATIONS OF CALIFORNIA, by W. L. Watts. Bulletin No. 19, California State Mining Bureau. 236 pages.

THE MOTHER LODE REGION OF CALIFORNIA, by W. H. Storms, E. M. Bulletin No. 18 of the California State Mining Bureau. 154 pages.

THE COPPER HAND-BOOK, by H. J. Stevens, Houghton, Mich.

328 pages. This book is largely of a statistical character and contains a large amount of interesting information relative to the Michigan copper mines.

CLAYS AND SHALES OF MICHIGAN, by H. Ries, Vol. 8, Part I, Geological Survey of Michigan, 67 pages. The scope of this book is shown by the chapter headings which are as follows: 1st, Properties of Clays and Shales; 2nd, Uses of Clay and Shale, and 3d, Tests.

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS. Chas. D. Walcott, Director, Washington, D. C.

Extracts from Annual Reports.

The Production of Zinc in 1899, by Chas. Kirchhoff.

The Production of Aluminum and Bauxite in 1899.

The Production of Cement in 1899.

ELEVATION AND STADIA TABLES, for obtaining differences of altitude for all angles and distances; horizontal distances in stadia work, etc., with all necessary corrections, together with Hydraulic Tables, giving velocities for various channels and slopes, by Arthur P. Davis, Mem. Am. Soc. C. E., Hydrographer U. S. Geological Survey. Published by John Wiley & Sons. Price, \$1.00. 43 pages.

UNIONTOWN, MASONTOWN, GAINES AND ELKLAND ATLAS SHEETS, issued by the United States Geological Survey, Washington, D. C., and the cooperative Topographic Survey of Pennsylvania. These sheets include a portion of the Connelleville Coal Region and the Coal Region of Central Pennsylvania in the vicinity of Wellsboro and Osceola. The sheets are 16½ inches by 20 inches in size, and the maps are drawn to the scale of 1 mile to 1 inch, with contour lines for every 20 feet of elevation. These sheets are for sale at 5 cents each, or at the rate of \$2.00 per hundred. Communications relative to them should be addressed to the Directors U. S. Geological Survey, Washington, D. C.

THE ROAD MAKING MATERIALS OF PENNSYLVANIA, by Magnus C. Ihlseng, E. M., C. E., Ph. D. 104 pages. Bulletin No. 69 of the Department of Agriculture, Harrisburg, Pa. This volume, upon a most interesting subject, is very well illustrated, and contains information of interest to all those who have to do with the making of roads. It points out that the State of Pennsylvania is amply supplied with material for making good roads, and if the state does not have these facilities, it is due to carelessness and indifference. The efforts of the Department of Agriculture to enlighten the people of Pennsylvania upon this important subject are worthy of the heartiest support.

12TH ANNUAL REPORT OF THE INSPECTOR OF MINES OF MONTANA, for the year ending Nov. 30th, 1900. John Byrne, Inspector of Mines, Helena, Mont. 86 pages. This report draws attention to the richness of the State of Montana in its mineral resources, and from this portion we will quote more at length hereafter. During the year covered by the report, 47 fatal accidents occurred, 40 of which were in metal mines and 7 in coal mines. As is usual in such reports, the verdict is that fully 50% of these were avoidable accidents, due to the lack of ordinary prudence on the part of the deceased. The remainder the Inspector attributes to "indifferent methods and contempt of an organized and regulated system of operations on the part of some managements." He says, "All our large mines are provided with the means necessary to make safe conditions and provide against accidents, but of what use are they, unless their use is systematically insisted on by those in authority." Among the improvements recommended by the Inspector, are 1st,—The appointment of two deputies to look after the rapidly increasing coal industry of the State. 2d, Provision for a second opening. 3d, Modifications in the law affecting safety apparatus. 4th, Providing for a maximum speed for hoisting men of 700 feet per minute except in shafts where the cages are provided with doors, where 800 feet may be allowed. 5th, Providing that the cross-head shall not be less than 6 feet in length. 6th, Prohibiting stoping up to a shaft, and providing for a pillar surrounding the shaft that will insure its safety.

PERSONALS.

Col. A. M. Shook, 2nd Vice-President of the Tennessee Coal, Iron and R. R. Co., has retired from that office, and the office has been abolished.

Mr. J. H. Williamson, Manager Viennot Advertising Agency, has removed his New York office from No. 127 Duane Street to Room No. 719 Temple Court.

Mr. A. E. Borie has been appointed general sales agent of Bethlehem Steel Company, with headquarters at South Bethlehem, Pa., the appointment dating from Feb. 1st, 1901.

Professor E. H. Williams, jr., of the department of Mining and Geology, of Lehigh University, has equipped a geological

laboratory for the microscopic study of rocks, which will be under the charge of Dr. Joseph Barrell, a frequent contributor to the columns of MINES AND MINERALS.

Mr. Jas. Bowron, Treasurer of the Tennessee Coal, Iron and R. R. Co., has been elected Chairman of the Executive Board of the Birmingham Savings and Trust Co., of Birmingham, Ala.

Mr. Reuben Street, has changed his address from McDonald, Pa., to New Salem, Fayette Co., Pa., where he has accepted the position of superintendent of Fayette Coke Co., with headquarters in New Salem.

Mr. Warren A. Wilbur, of South Bethlehem, Pa., has given \$5,000 for the equipment of a Mechanical Laboratory at Lehigh University. It will be installed on the first floor of the new physical laboratory building.

Mr. Isaac G. Roby of Uniontown, Pa., has been commissioned as Mine Inspector of the 5th Bituminous District, Uniontown, Fayette Co., Pa., to fill out the unexpired term ending May 14, 1901, of Mr. Chas. Connor, who has taken a position in Nova Scotia.

Charles T. Schoen, president of the Pressed Steel Car Company since its organization in 1899, has resigned that position, and the vacancy has been filled by the election of F. N. Hoffstat, of Pittsburgh, a director. Mr. Schoen remains chairman of the Board of Directors of the company.

Mr. Sidney A. Stephens, 22 St. John St., Montreal, Canada, has been appointed agent throughout the Dominion of Canada for Ashton pop safety valves and steam gages made by The Ashton Valve Co., manufacturers high grade pop safety valves, pressure and vacuum gages, etc., of 271 Franklin St., Boston, Mass.

Mr. W. Chas. Mundt, manager of Chas. Mundt & Sons, Perforated Metals, 88 Walker St., New York, met with a serious accident on January 26th. In attempting to stop a machine, his right hand was caught, and badly crushed and cut. It is hoped the hand can be saved, but it will be permanently crippled.

Mr. M. P. Simpson, who has for a number of years been store manager for the H. C. Frick Coke Co., has been appointed superintendent of the Redstone mines of the same company located at Brownsfield, Pa., succeeding Mr. Leo Bullion, who has been superintendent at Brownsfield for the past six years.

Mr. Charles Connor, for some years past, Inspector of the 5th Bituminous District, with headquarters in Uniontown, Fayette Co., has resigned that position to become general superintendent for the Union Coal Co., Ltd., Cape Breton, Canada. Mr. Connor carries the best wishes of his many friends in Pennsylvania with him, to his new field of labor.

Mr. John N. Pott, mining engineer, who for several years has been assistant engineer in the mining, engineering and surveying department of the Cambria Steel Co., has resigned and will open an office in Johnstown, Pa. Mr. Pott has had an extensive experience as a mining engineer, having had practical experience in various parts of the country, where he has been connected with coal mining concerns, and is familiar with the various methods of mining and handling coal.

E. L. Fuller of Scranton has purchased the entire interest of the Newton Coal Co. These mines include 1,500 or more acres and extend from the Clear Spring colliery at Pittston to the Babylon breaker at Old Forge. There are three breakers, the Seneca, Phoenix, and Columbia, the latter now being converted into a washery. The distance of land occupied by the company is something over two miles. It will be conducted under the name of the Seneca Coal Co., with E. L. Fuller, president, Henry Sively, secretary, and M. B. Fuller, treasurer.

We are glad to write that Mr. Herbert E. Goodman, treasurer and general manager of the Goodman Manufacturing Co., 48th Place and Halsted St., Chicago, Ill., has practically recovered and is again able to attend to business. Mr. Goodman's friends will recall that several months ago he was examining a machine in a mine in Pennsylvania and although the machine was not running at the time a car broke loose in the entry and in the excitement to get out of the way somebody turned on the current of the machine and Mr. Goodman was caught in the cutters. One leg was so badly injured that it had to be amputated.

Dr. Toshi Suzuki, Mining Geologist of the Government Imperial Steel Works, at Tokio, Japan, sailed from San Francisco on the 19th ult., after several weeks spent in the United States, studying American mining methods and mining machinery, especially compressed air and coal cutting machinery. Dr. Suzuki, previous to coming to the United States, spent some time in France, Belgium, Prussia and Great Britain, and returns to his native land with a vast amount of information regarding European and American mining methods and appliances, which will undoubtedly result in benefit at the coal mines connected with the Imperial Steel Works.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The editor is not responsible for views expressed by correspondents in this Department.

Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Rope Haulage.

Editor Mines and Minerals:

SIR:—Will some reader of your paper please give me the following information? I am a mine boss where there is an incline 2,200 ft. long which has two very short curves, necessitating upright sheaves for the rope, and our trouble is to get a hitch to put on the hind wagon to carry the rope low enough to catch the sheaves, as it is impossible to hitch the rope on the front wagon on account of the wagons lock bumping on the curves. Would be very glad if some one would inform me how such a hitch could be obtained. We have 10% grade on incline.

Yours truly,
D. S. M.

Black Lick, Pa.

Jockeys Used In Endless Rope Haulage.

Editor Mines and Minerals:

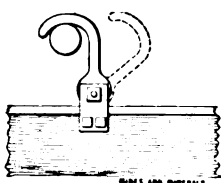
SIR:—We are installing a haulage plant at our mine which we propose to work upon the endless rope system, carrying the rope over the cars, which are attached to it by means of a jockey placed on the top of the car to hold the rope down in place. As this system of attaching the cars to an endless rope is not treated in books upon haulage, as far as I have been able to learn, I would like to know if you consider the plan practicable. It has been adopted very largely for mine haulage on the surface at Johannesburg, Africa. I will state that the haulage roads are practically straight. Where curves do occur in the haulage road, it is proposed to knock the rope out of the jockey, and carry it upon bearing rollers around the curve. The cars would have to be pushed around the curve by hand until the rope could again be inserted in the jockey. Could curves be introduced successfully into such a haulage road without the rope leaving the jockey?

R. W. P., Velardina, Mex.

The system mentioned by our correspondent of attaching the cars to the rope, is one that has been much used in certain localities. It is specially adapted to straight haulage roads that are level, or uniform in grade. It has been used where there are curves in the road, but is not adapted to haulage where the grade of the road is undulatory. The system has been in use for some time at slopes No. 3 and No. 6 of the Tennessee Coal, Iron & Railroad Company at Pratt City and at Ensley, Ala., and a description of these haulage plants has been given in MINES AND MINERALS, Vol. XX, page 251, January, and Vol. XXI, page 220, December, 1900.

The points raised by R. W. P. were submitted to Mr. C. E. Bowron, assistant chief engineer of the Tennessee Coal, Iron & R. R. Co., who writes in regard to the plants above referred to in MINES AND MINERALS:

We experienced a great deal of trouble at first from the rope lifting out of the jockeys or clips, as we call them. We remedied this by attaching a small hook to the front of the car, the clip being on the back end: we hook this hook over the rope



so that it is always held in the clip: we have found it advisable not to have any abrupt breaks in the grades of this style of haulage. Where the haulage runs down a slope and then onto a flat, the knuckle should be well rounded off; similarly in the case of marked changes of grade while on the slope. When the breaks are thus rounded off, the weight of the rope will keep it down off the roof. I do not think this style of haulage would be advisable where the changes in grade would be convex unless the changes were very gradual, on account of the strain on the cars in coming over the knuckles. We have not yet met with this particular condition and therefore my opinion is merely a surmise.

Yours truly,
CHAS. E. BOWRON,
Asst. Chief. Engr.

Birmingham, Ala., Dec. 27, 1900.

Home Made Assay Furnace.

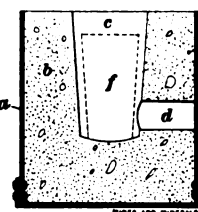
Editor Mines and Minerals:

SIR:—I have a kerosene brazing lamp giving an erect blue flame 9 inches long and capable of easily melting $\frac{1}{4}$ " copper rod in 3 minutes. Can you tell me size and materials to make an assay furnace suitable for either crucible (10 gramme size), or muffle operations. I do not know the best way of applying the flame nor the proper proportions of the furnace. An answer in your columns would be greatly esteemed.

No. 29, Kobe, Japan.

Yours truly,
JAS. L. ROBERTSON.

A furnace could be made by taking fire clay *b* and packing it in any suitable metal frame *a*, as for instance a casing made of tin or sheet iron bent to proper form and riveted together. A wooden plug should be cut to the general form of the crucible and slightly larger and inserted in the center of the casing and the clay packed around it so that when the plug is withdrawn it will leave an opening as shown at *c*. If the flame of the lamp can be turned horizontally an opening should be made at right angles near the bottom of the opening *c*, as shown at *d*, and the flame of the lamp turned into this opening so that it will heat the crucible, which will stand in the position shown by the dotted lines *f*. The top of the opening *c* can be closed by laying a fire brick in such a position that it covers nearly all of it or by laying two fire bricks close together so as to leave a very narrow opening between them through which the products of combustion may escape. If the flame can only be arranged vertically the crucible will have to be supported upon small pieces of fire clay and an opening made through the bottom of the casing and the flame directed up against the bottom of the crucible. This latter arrangement is not nearly so handy on account of the fact that if the crucible boils over the slag will run down upon the burner.



Shaft Timbering in Swelling Ground.

Editor Mines and Minerals:

SIR:—My method of securing a shaft that is sunk through ground that swells is to use round timber, oak or hard pine, 8 to 10 inches in diameter for cribbing. Leave 2 to 3 inches between sets by placing a 2 or 3 inch cleat on each corner of each set, and one behind the wall plates and guides. Spike the cleats fast to the sets; this keeps the sets a uniform distance apart and prevents sagging. The round backs of the timber will direct the ground as it swells towards the openings between the sets where the extra pressure due to its swelling will readily force it through and it will be carried to the shaft bottom either with the cage or by crumbling of itself. If a set of timber shows signs of strain at any time it can be relieved by going around the openings next to it with a pick and cutting out the dirt. By this method very little swelling of the ground will be noticed as it has perfect drainage from the first and no water is retained behind the timber. If the lagging behind slope timbers be treated the same way the timber will be greatly relieved of the pressure due to the expansion and swelling of the ground.

Spring Valley, Ill.

Yours truly,
DYNAMITE.

Misfire Shots.

Editor Mines and Minerals:

SIR:—I have had shots to miss fire in exploding them with the battery. In rounds of from 6 to 10 holes 1 to 4 of them have missed fire. On returning to the shaft after blasting if I discovered any holes that missed I connected them up again and fired them at once. If the loose rock was partly loaded out when I discovered them I preserved them until all that was loose was loaded and then I connected them up and fired them.

I have gone into the shaft 24 hours after firing was done and discovered a missed hole, took hold of the detonator wires and pulled it and the cartridge containing it out of the hole, have separated them and connected the detonator to the battery and exploded it. I never had but one hole that I tried to explode the second time fail to go off if I have exploded them 2 hours after they had missed, even in a wet shaft where pumping was necessary. When two or more men charge and connect the same round of holes it is hard to say what has been done that would cause a misfire of some of them. I have seen men who would force the cartridge containing the detonator into the hole with the same rashness as they did the first stick of dynamite of the charge, and if care is not exercised in putting the cartridge containing the detonator into the hole they may get separated a sufficient distance to cause a misfire of the charge, although I never knew of such a case. I have discovered a missed hole that was missed in the connection of the round and I am of the opinion that some detonators require a stronger current to

explode than others, and that, this, sometimes causes a misfire. A current from a battery over a wire 800 or 900 feet long is not quite as strong as it is over 50 or 100 feet of wire, a battery that has been in use 8 or 10 months without recharging is not as strong as one that is newly charged, a slow and feeble pull or plunge of the battery plunger will not produce as strong a current as a quick and sudden jerk or plunge. The detonators which are hard to explode will perhaps pass such currents as these conditions would yield and remain unexploded. There is one method that I practiced in connecting the detonator to the cartridge which I discovered was a cause of misfiring. If the battery wires make a half-hitch around the cartridge containing the detonator, as is often done and if the insulation on the wires is loose and soft, very little strain on the wires by tightening them will produce naked wires and bring them together sufficiently close to produce a return circuit between them so the current will never reach the detonator. This I have experienced and found to be one cause for misfire of some holes and if any one will try very easy in the hot summer days or when the detonators are kept in a hot shanty they can produce the evidence of the fact and satisfy themselves of it being so.

Yours truly,
Spring Valley, Ill.

DYNAMITE AND BLASTING.

Timbering in Swelling Ground.

Editor Mines and Minerals:

SIR:—Please allow me a little space to answer J. T. L., of Norway, Mich., in regards to swelling strata, having had several years' experience as a timber or repair man in such strata, with sandstone foot rock. 1st. I would suggest the strongest timbers obtainable, butts preferred, framed so that they will be skin to skin to stand every pound of strain. 2d. Have at least one round side to your timber, place this to soapstone, and if not round make it so with heavy slab; place your timbers about 3 feet apart or 4½ feet from center to center. 3d. Wedge your timber only at the ends, and on no account let a wedge be driven between the end pieces or side pieces, lay your timbers as loosely as possible for they will tighten of their own accord. 4th. Get round poles or lagging about 4½ feet long from 5 to 6 in. thick split in two, place these behind your timber with round side to soapstone and from 4 in. to width of lagging apart, so that the water and strata can push through so as to ease the timber, it being understood that if too wet or liable to run, which it sometimes will do until it is drained, the lagging should be put a little closer; this must be left a little to the judgment of those employed.

In case the shaft is used as a hoisting shaft or otherwise men are employed therein, planks or boards should be cut the length and breadth of the shaft and placed behind the hanging boards of the shaft, these will form a cupboard to catch and hold all the strata that may push through, and should be kept reasonably clean. If your timbers show too much stress or if there is too much stress on the lagging, ease behind them or cut them out altogether and relay the set all around, you may have trouble and a great deal of it, but don't let it break on you and it will settle after a while.

Yours truly,
Johnstown, Pa.

JOHN RETALLUCK.

Mine Pumps.

Editor Mines and Minerals:

SIR:—We had a pump delivering 120 gallons per minute under a head of 110 feet. The pump was located 900 feet from the boiler and had a length of suction pipe of 450 feet; one boiler was required to run the pump. Thinking to better the situation we moved the pump to within 20 feet of its water supply, which reduced the suction lift to one-half what it was previously and the head to only 60', but increased the length of the steam line supplying the pump to 1,600 feet. This line is 2 inches in diameter. The pump now delivers 160 gallons per minute, but uses so much steam that we find two boilers are now required. It will cost about \$250.00 to cover the steam line supplying the pump with asbestos covering, which would probably reduce the cost of steam from condensation. However, I am annoyed that the pump requires so much more steam than before; can you kindly suggest the reason for this?

Yours truly,
Mud River, Ky.

J. C.

Sufficient data are not given to enable us to explain fully all your trouble. However, in moving your pump nearer to the water supply we understand the steam line was increased from 900 feet long to 1,600 feet long, while the head under which the pump worked was decreased from 110 feet to 60 feet. The fact that the suction pipe was decreased in length would act to increase the efficiency of the pump to a certain extent, but on the other hand, the pump is now handling 160 gallons of water per minute against 120 gallons previously. This means an increase of power in the ratio of $(\frac{4}{3})^3 = 2.37$. The decrease of head would result in a decrease of power in the ratio of $\frac{60}{110} = 1.83$. Therefore,

under the present conditions you are using necessarily more power than previously, in the ratio of $\frac{2.37}{1.83} = 1.3$. That is to say, where

you required 10 horsepower previously you now require 13 horsepower, and of course, this requires more steam. Moreover, the fact that you have to carry your steam 1,600 — 900 = 700 feet farther, entails a larger percentage of loss by condensation in the steam line. There would also be required a higher pressure at the boiler in order to maintain the same pump pressure as previously. These considerations show that you would naturally expect to consume more steam, and would therefore require two boilers instead of one under this arrangement.

Arizona Notes.

Editor Mines and Minerals:

SIR:—Arizona's chief industry is mining, and the last year of the century just passed away has been the busiest and most prosperous in that line the territory has ever had.

The output of the mines in Arizona for 1900 clearly demonstrates to the careful conservative mining man that this country is bound to become the greatest and most productive mining country in the world. Outside investors have but recently become informed as to the great mineral resources here awaiting their help, and offering opportunities no other section of this fair land of ours or any other country on earth can offer. I am aware of the fact that thousands of people have been led to believe our climate something to be shunned. Many hardly ever speak the name Arizona without connecting it with the lower regions politely termed "Hades."

This is not only wrong but unjust. With a climate unsurpassed, in summer or winter, where one can work every day in the year it cannot help but be favorable to the investor in mines. Water in abundance can be had by going down for it and in many of the mines they now have more than they want. With the hills ribbed with mineral-bearing ledges rich in gold, silver, copper and lead, and in many cases some of the rarer minerals as tungsten and molybdenum, and many of them high in grade, and others that are termed low grade, but immense in size from 10 to 60 feet wide that will average all the way from \$6 to \$50 per ton—ores for concentration, cyaniding, smelting, and milling—why should it not be a paradise for the miner and mining investor?

When we take into consideration that the year just passed away was a Presidential election year, and that capital is always shy during those times, we feel that the results shown for the year are all the more remarkable. We have no way of determining exactly the entire output of the precious metals, but I believe that \$40,000,000 would be an exceedingly conservative estimate, copper in the lead with about \$28,000,000; gold \$8,000,000; silver \$3,500,000 and lead \$1,000,000. I believe this will be largely increased the coming year, from the fact that a number of the larger producers of copper were closed down for some time, while installing new plants and for extensive repairs, and a number of others will come in this year as producers for the first time, and many old ones that have been shut down for years are being unwatered and put in shape to take their place in the bullion producing line. A number of properties have changed hands in the County of Mohave since the election and development has commenced in earnest on them. The capital has come from New York, Massachusetts, and Pennsylvania, but the larger amount I think has come from the Keystone State. The hills are full of prospectors and many fine strikes have been made. I have with me a young man from Ohio, who is a student in the mining engineering department of The International Correspondence Schools, of Scranton, and he is doing well, has three good locations and is going at it in a thorough business-like way. I would say to those who wish to invest their means that if they will exercise a little business caution in making their investments there is no mineral field that offers surer or better returns than Arizona. I expect to visit the great copper camp of Jerome next month and should I make the trip I may have something of interest to send you from there.

Yours truly,
Kingman, Ariz.

W. A. MENSCH.

A Gravity Plane.

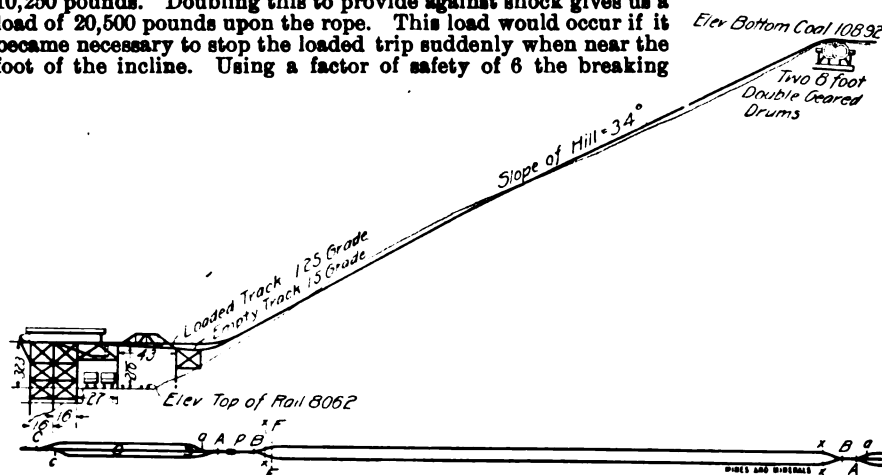
Editor Mines and Minerals:

SIR:—We are about to make a new opening in a coal seam that outcrops 300 feet above the level of the railroad tracks. It is proposed to install a gravity plane at this opening, for the purpose of lowering the coal from the mouth of the drift to the tippie floor, which is about 32 feet above the tracks. The natural slope of the ground is about 34° and quite regular along the line of the incline. It is proposed to use two barneys weighing 1,500 pounds each, and to lower four cars in a trip, the weight of the empty cars being 1,200 pounds each, and having a capacity

of 2,800 pounds of coal, making the total amount of material lowered at a time $2,800 \times 4 = 11,200$ pounds. There will be two 8-foot, double-gear drums, at the head of the plane. Will you kindly inform me, if it will be necessary to have two empty tracks on the tippie floor, in order to work the barney on the rear of the empty track going up? In your opinion, will it be safe to lower four loaded cars in the trip on such a steep incline, and if so what size of rope should be used? Please give the best arrangement of tracks upon the tippie. The length of the incline from the knuckle to the tippie floor below is 510 feet.

L. P. F., Charleroi, Pa.

From the data given and assuming a one-inch rope weighing 1.58 pounds per lineal foot, we estimate the gravity pull upon the rope when the loaded trip is near the bottom of the incline, to be 10,250 pounds. Doubling this to provide against shock gives us a load of 20,500 pounds upon the rope. This load would occur if it became necessary to stop the loaded trip suddenly when near the foot of the incline. Using a factor of safety of 6 the breaking



strain is 61.5 tons. A $1\frac{1}{2}$ -inch plough steel rope having a breaking strain of 64 tons weighs 2.45 pounds per lineal foot, which will increase the gravity pull upon the rope to, say 10,500 pounds instead of 10,250 pounds as previously stated, making the load under shock 21,000 pounds. This will give a factor of safety, $\frac{64 \times 2,000}{21,000} = 6.1$, which is ample.

In order to determine the force which it will be necessary to overcome with the brake applied to the drum or brake-wheel, at the top of the plane, in order to control the loaded trip, we observe that the weights of the barneys and cars in the ascending and descending loads balance each other. When the loaded trip has arrived near the bottom of the plane, the unbalanced load upon the drum will be the gravity pull due to the weight of the material and the weight of the rope, which is $(2,800 \times 4 + 2.45 \times 510) \times \sin 34^\circ = 12,450 \times .559 =$ say 7,000 pounds. With a good brake it would be easily possible to apply this restraining force to the movement of the cars.

Three tracks are often employed at the head and three tracks at the foot of the incline. At the head of the incline the center track is for the loaded cars, while the two outside tracks are for empties; at the foot of the incline the arrangement of the tracks is the reverse of this. It is always the safest plan to have two separate tracks throughout the entire length of the incline, although some inclines are built with but a single track throughout the entire length from top to bottom, except a passing track which is arranged at the middle of the incline. The object of employing three tracks at the top and bottom is to provide sufficient track room to allow of the continuous operation of the plane, in case of a slight delay in loading at the tippie, or a delay at the head of the plane. This is the more necessary as its capacity is usually taxed to the utmost in the lowering of the output to the tippie. Wherever there is sufficient length at the tippie and at the head of the plane, however, to furnish the necessary track room, two tracks may be used instead of three. Where barneys are employed attached to the ends of the rope instead of attaching the rope directly to the trip itself, it is generally better to bring the two tracks together at the foot and at the head of the incline, by means of the switches marked *B* and *B*. These switches are arranged to be operated automatically, by the movement of the cars; so that when a trip of cars passes through it, off of the incline, the switch will be set ready for the following trip to return to the same track upon the incline. The switch may be operated by the arrangement of a short lever close to the rail, and which will be depressed as the cars pass over it. These levers should be located at the points marked *x, x*, in each track, near the foot, and the head of the incline. The switches marked *A, A*, and *a, a*, are all automatic spring pole switches that are kept

set for the two side tracks at the head and at the foot of the plane alike. The center track for loaded cars at the head of the plane, and the center track for empty cars at the foot of the plane are always out-going tracks, and the cars from these tracks will pass through these switches automatically, the spring pole setting the switch again for the side tracks after the passing of the cars. If the left hand track is full, it is the duty of the footman to close the first switch *A*, which should be supplied with a lever for that purpose. The second switch *a*, will never require to be set by the footman, being operated by the spring pole only, so that the right hand loaded track is always open for use at any time. The two loaded tracks pass over tipples where the cars are dumped, and connect beyond the tippie, by automatic switches, with the center empty track. The empty cars, after being dumped, run by gravity

through the switches *C* and *c*, which are automatic spring pole switches always kept set for the center track, and thence up a short steep incline, and switch back upon the center track automatically, to a point marked *O*. At this point they must be elevated two or three feet, to a height somewhat above the level of the loaded tracks, so that they will run forward toward the barney pit *P*, or a mule must be used as is often done. A block is placed at the point marked *S*, to prevent their running out upon the switches, until allowed to do so by the footman. This block at *S* can be so arranged that the empty cars will be released automatically, as the loaded trip passes onto the siding at either side. The empty cars will then run by gravity toward the barney pit *P*, the footman pushing them forward until the last car has passed over the barney, where they will be in position to ascend the plane, when the system is started.

It is not clear to us how the empty track can be operated in the position shown on the profile, inasmuch as the barney must release the loads by sinking into a pit, at a point outside of the siding switches, and on level track, where it can be reached by the empties, which must pass on over it. The barney cannot be switched to the rear of the empty trip.

J. T. B.

CATALOGUES RECEIVED.

In writing for catalogues, please mention *Mines and Minerals*.

THE GEAR CUTTERS, R. D. Nuttall Co., Pittsburg, Pa. 45 pages.
CATALOGUE A. Cross, Laughlin & Co., Room 400 Fullerton Bldg., St. Louis, Mo.

THE ECONOMY OF QUALITY. The Martin Hardsocg Co., Ottumwa, Ia. 16 pages.

HOWELLS MINING DRILLS. Howells Mining Drill Co., Plymouth, Pa. Illustrated. 58 pages.

PARKER STEAM GENERATOR. Parker Engine Co., Drexel Bldg., Philadelphia, Pa. 26 pages.

NARROW GAUGE RAILWAY MATERIALS. Arthur Koppel, New York. 104 pages, illustrated.

"MANHATTAN HOTEL." The Goheen Mfg. Co., Canton, O., 1 page. Carbonizing Coating.

UNIVERSAL EXHAUST STEAM INDUCTION CONDENSER. L. Schutte & Co., Philadelphia, Pa. 24 pages.

THE PITTSBURGH SAFETY WATER COLUMN. Pittsburgh Gage & Supply Co., Pittsburgh, Pa. 1 page.

CLAYTON AIR COMPRESSORS. Clayton Air Compressor Works, Havemeyer Bldg., New York. 80 pages.

ORE MILLING AND SMELTING EQUIPMENTS, Colorado Iron Works Co., Denver, Colo. 56 pages, illustrated.

"TO CEMENT MAKERS." The Williams Patent Crusher & Pulverizer Co., St. Louis, Mo. 1-page circular.

RECORD OF RECENT CONSTRUCTION, NUMBER TWENTY-ONE. Baldwin Locomotive Works, Philadelphia, Pa. 32 pages.

MINING MACHINERY, STEAM ENGINES. M. C. Bullock Mfg. Co., 587 The Bourse, Philadelphia, Pa. 4-page folder (No. 43).

"K-U-T-A," CAYUTA WHEEL AND FOUNDRY Co., Sayre, Pa. Chilled Car Wheels, Valves, Fire Hydrants, etc. 51 pages.

GOLD DREDGING MACHINERY. The Ridson Iron Works, San Francisco, Cal. Catalogue No. 17. Illustrated. 50 pages.

THE ASHTON VALVE Co., Boston, Mass. Ashton Lock-up Pop Safety Valves, Ashton Pressure and Vacuum Gages. 80 pages.

THE PHILLIPS "BADGER" DRILL. The Phillips Rock Drill Co., N. W. Cor. 7th & Filbert Sts., Philadelphia, Pa. 20 pages.

THE GREEN BOOK OF HARDWARE SPECIALTIES. Smith & Hemenway, and the Utica Drop Forge and Tool Co., New York. 45 pages.

"DIXON'S NOVELTY ERASER." 1 page. "Graphite as a Lubricant." 44 pages. Jos. Dixon Crucible Co., Jersey City, N. J.

ENGINES AND BOILERS, CATALOGUE No. 1. Fraser & Chalmers, 12th St. & Washtenaw Ave., Chicago, Ill. 132 pages, illustrated.

THE JEFFREY MFG. Co., Columbus, Ohio. Chain Belting and Steel Cable, Elevating and Conveying Machinery. Illustrated. 276 pages.

SOMETHING NEW. Boston and Lockport, Block Co., 142 Commercial St., Boston, Mass. Star Malleable Iron Block. 1 page. Also souvenir blotter.

WILLIAMSPORT WOODEN PIPE Co., Williamsport, Pa. 10 pages. Wooden Water Pipe, Tanners' Liquor and Water Pipe, Column and Suction Pipe, etc.

MODERN ORE CONCENTRATION AND MILL PRACTICE. The Colorado Iron Works Co., Denver, Colo. 24 pages, containing a description of the New Iron Top Bartlett Concentrator.

CALENDAR NOTE BOOKS.

VULCAN IRON WORKS Co., Toledo, Ohio.

UTICA DROP FORGE & TOOL Co., New York.

KRUEFFEL & ESSER Co., 127 Fulton St., New York.

THE GREEN BOOK OF HARDWARE SPECIALTIES. Smith & Hemenway Co.

CALENDARS RECEIVED.

VULCAN IRON WORKS, Toledo, O.

WESTON DODSON & Co., Bethlehem, Pa.

MARION STEAM SHOVEL COMPANY, Marion, Ohio.

J. GEO. LEYNER, 729 Seventeenth St., Denver, Colo.

RISDON IRON and LOCOMOTIVE WORKS, San Francisco, Cal.

Wyckoff Wood Pipe for Mining.

A superior wood pipe for mining purposes is manufactured by the A. Wyckoff & Son Co., Elmira, N. Y., and is known as the patent acid proof wood pipe. In it is offered the substitute for a metal conveyance which mine operators have long been looking for.

This wood pipe is not affected destructively by the sulphur and other impurities of mine water and is extremely durable, being made of especially selected white pine, entirely free of sap, no yellow or jack pine being employed in its manufacture.

It is furnished in lengths of from four to eight feet, and is easier and more cheaply laid than iron pipe.

The sections are connected by tenon and socket joints, and when driven together make a perfectly air and water tight joint.

The Wyckoff wood pipe is equally satisfactory for suction or discharge lines, and special connections for pumps are furnished,

with wood elbows, tees, and any bend required.

It can be strengthened to stand any pressure up to 370 feet head.

The manufacturers have furnished this pipe so extensively to the operators in the

mining districts of the country, under so many varying conditions, and with such satisfactory results, that it is strongly commended for the use of any operator who uses a conveyance for draining his mine. The first cost of wood pipe is cheaper than metal, and being so much more durable, lighter and easier handled, it has proved by far the most economical conveyance for mine use.

The A. Wyckoff & Son Co. will be glad to send full descriptive circulars with price lists on application, and those replacing or about to put in a pipe line will find it advantageous to thoroughly investigate the merit of the Wyckoff acid proof wood pipe.

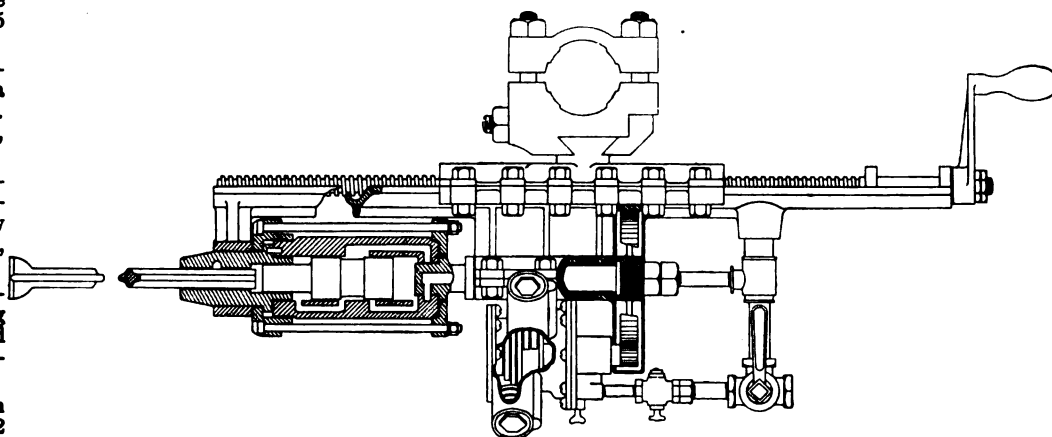
The illustration shows the pipe strengthened, as generally employed for mining purposes.



STRENGTHENED WYCKOFF WOOD PIPE.

Chicago-Schmucker Rock Drill.

The "Chicago-Schmucker" rock drill, here illustrated, combines the principles of a pneumatic hammer and a pneumatic drill. In the cylinder of the hammer is set a drill bit made of grooved steel $\frac{1}{2}$ inch in diameter of any desired length. The



chuck is cut out to fit a cross section of the drill bit, so that the bit can be set in the hammer socket loosely, requiring no set screws, bolts, or pins to hold it in place. A tube encasing the drill bit is encircled by a spiral, which, when the drill bit revolves, removes from the hole as the drill advances, the cuttings of rock and other material, similarly to an auger bit. Four tongues, riveted to the internal diameter of the casing, fit the four grooves in the bit, compelling it to rotate simultaneously with the drill.

The hammer strikes 4,000 blows per minute, with a stroke of $1\frac{1}{2}$ inches. This light blow requires a small supply of air and causes no vibration. Thus, the bit can be made as hard as fire and water will make it, and still not fracture, giving great wear of steel between sharpenings.

A water attachment is provided so that in case of striking wet spots in the course of operations, the water follows the grooves to the bit, thus getting water just where needed. The drill motor portion of the machine has no other duties to perform than to rotate the spiral for removing refuse matter from the drilled hole, and rotate the bit, so that its consumption of air is slight. This engine is situated just in the rear of, and slightly above the hammer, making 125 revolutions per minute during the 4,000 blows of the hammer. In order to change the bits it is unnecessary to do any more than pull the bit from the chuck and insert the longer bit as the work progresses.

The points of superiority claimed for this drill are great efficiency; compactness; lightness and portability; durability; and economy in the consumption of air.

Some of the Colorado mines using these drills are Lamartine, in Chicago Gulch, Clear Creek district; the New Era, at Freeland; the Monita, at Salida; the Sun and Moon, at Idaho Springs; the Percy Consolidated, at Aspen; the Independence Consolidated, the Kitty Lane, C. O. D., and Matoa, at Cripple Creek, Colo.

These drills, which were formerly manufactured by the Great Western Pneumatic Tool Co., of Denver, are now being made in Chicago.

Central Canada Chamber of Mines.

Editor Mines and Minerals:

By direction of the Council of this Institute I beg to append copy of a Resolution unanimously passed at a meeting of our Board held in Montreal on 31st. ultimo.

By giving the resolution space in your columns you will aid the best interests of the mining industry and mining profession in Canada. I am,

Ottawa, Feb. 7th., 1901.

Yours faithfully,

B. T. A. BELL,

Secretary The Canadian Mining Institute.

RESOLUTION.

The Council of the Canadian Mining Institute having considered the circular letters and publications of an organization called the Central Canada Chamber of Mines, and believing that the indiscriminate publication and distribution of this literature, containing false and misleading statements, is prejudicial and hurtful to the mineral interests of Canada;

Resolves: To put on record this expression of its views on the work and procedure of the Chamber and at the same time to express its unqualified disapproval of any financial aid or assistance being given to it by the Dominion or Provincial Governments, and further

Resolves: That the Secretary be authorized to communicate this resolution to the President and Secretary of the Central Canada Chamber of Mines, to the Honorable the Minister of the Interior, to the Honorable the Commissioner of Crown Lands for Ontario and to the editors of the leading Canadian and foreign press.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decisions as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes, and to mention the numbers of the questions when so doing.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for March.

QUES. 660.—*Roasting Silver Ores*.—Describe briefly the roasting of an argentiferous ore composed of sulphates, arsenates, and antimonates.

QUES. 661.—*Examining for Gas*.—If you were examining the condition of the main return airway in a very gaseous mine, (a) What kind of lamp and flame would you use? (b) Would you travel with or against the current? Explain fully.

QUES. 662.—*Setting Post Timber at the Face*.—Explain fully how you would set a post at the face of a breast in a flat seam, 5 feet thick, under 250 feet of cover, the roof and floor being hard. Give size and kind of timber you prefer.

QUES. 663.—*High Tension and Low Tension Exploders*.—What is the essential difference between high and low tension exploders? Explain their relative advantages and disadvantages.

QUES. 664.—*Locating Error in a Survey*.—Following are notes of a surface survey enclosing a plat of ground.

Sta.	Angle.	Distance.	Sta.	Remarks.
1	R 102° 30'	250	2	B. S. = Sta. 5.
2	R 64° 55'	500	3	
3	R 35° 25'	825	4	
4	R 78° 50'	242	5	
5	R 93° 20'	1,400	1	

As this survey does not close there is evidently an error in the work or notes. Explain how you would proceed to locate this error in the quickest manner possible, assuming that the work has been done carefully throughout, and that therefore the trouble arises from a single error, at some point of the survey, instead of several errors.

QUES. 665.—*Brakes vs. Sprags for Mine Cars*.—Which do you prefer in the equipment of mine cars, brakes or sprags? State the reason for your choice.

QUES. 666.—*To Calculate Magnetic Bearing*.—The direction of certain chambers is given upon a mine map as S 84° 15' E. If the declination of the needle (magnetic variation) is 8° 40' E, explain how you would proceed to give the proper sights for these chambers, with only a plain compass at your command. In other words, calculate the magnetic bearing of the sight lines of these chambers.

QUES. 667.—*Sizes of Suction and Discharge Pipes of a Pump*.—What should be the diameters of the suction and discharge pipes, respectively, for a pump delivering 5,000 gallons of water per hour?

Answers to Questions Which Appeared in the January and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 644.—*Gravity Plane*.—(a) How many cars should be run in a trip upon an incline 5,000 feet long and having an inclination of 4° 30', when the cars weigh 1,800 pounds each and have a capacity of 3,200 pounds of coal? (b) At what velocity should the cars be run on this incline to lower 96 tons of coal per hour, allowing one minute between trips for change of rope and loss of time in starting and stopping? Calculate the angle of inclination and the length of the steep pitch at the head of the incline to give this required velocity. Assume the coefficient of rolling friction as .025, and use a $\frac{1}{2}$ -inch rope weighing .88 pound per lineal foot and having a breaking strain of 25 tons.

Ans.—Using the formulas explained in the article Gravity Planes, page 284, MINES AND MINERALS, January, 1901. The first step is to calculate the values of the ratios r and r_1 ; thus,

$$r = \frac{w_c}{2W} = \frac{3,200}{2 \times 1,800} = .889,$$

$$\text{and } r_1 = \frac{w_r l}{2W} = \frac{.88 \times 5,000}{2 \times 1,800} = 1.222.$$

Then, substituting values in equation 1 we have for the number of cars required to form a trip, in this case,

$$n = \frac{1.222(.07846 + .025)}{.889(.07846 - .025) - .025} = 5.6, \text{ say } 6 \text{ cars.}$$

The next step is to determine the velocity at which the cars should be run, or the time of making one trip; thus, $\frac{6 \times 3,200}{2,000} \times \frac{60}{96} = 6 \text{ min.}$, time for each trip. But one minute is required for change of rope and starting and stopping each trip; then $6 - 1 = 5$ minutes is the actual running time for each trip, and the required velocity is, therefore, $\frac{5,000}{5 \times 60} = 16\frac{2}{3} \text{ ft. per sec.}$ The third step is to determine the grade of the steep pitch at the head of the incline, and also the length of this steep grade that will produce the required velocity. Substituting the given values in equation 3 we have for the angle of inclination of this pitch.

$$\sin \beta = \frac{2 \times .025 \times 6(.889 + 1) + 1.222(.07846 + 2 \times .025)}{6(.888 + .5)} = .08684; \text{ and } \beta = 4^\circ 59'.$$

The length of this steep grade will depend upon the acceleration of the system, which is calculated by means of formula 4, $f = \frac{p_1 - p_2}{p_1 + p_2} \times g$. We must first, however, determine the values of p_1 and p_2 , respectively, or the pulls producing and resisting motion.

$$p_1 = 6(3,200 + 1,800).08684 = 2,605 \text{ lb.}$$

$$p_2 = 6(3,200 + 2 \times 1,800).025 + .88 \times 5,000(.07846 + .025) = 1,475 \text{ lb.}$$

Substituting these values in formula 4, we have for the acceleration of the system,

$$f = \frac{2,605 - 1,475}{2,605 + 1,475} \times 32.16 = 8.9 \text{ ft. per sec.}$$

Then, from formula 5, we have for the length of the steep pitch,

$$l = \frac{v^2}{2f} = \frac{(16\frac{2}{3})^2}{2 \times 8.9} = \left(\frac{50}{3}\right)^2 \times \frac{1}{17.8} = 15.6 \text{ ft., say } 16 \text{ feet.}$$

N. G. BOLLING, Greensburg, Pa.

Second Prize.—C. E. BOWRON, Birmingham, Ala.

QUES. 645.—*Mining Two Contiguous Seams of Coal*.—Describe how you would proceed to mine two contiguous seams of bituminous coal, separated by 30 inches of clay parting. The lower seam is 3 feet 6 inches thick, and the upper seam 2 feet in thickness. The quality of the upper seam is particularly good while the lower seam contains considerable sulphur (pyrites). The floor of the lower seam is a fire clay 18 inches in thickness, which readily heaves. The stratum overlying the upper seam is a hard slate 25 feet thick. The seam is flat, lying at a depth of 200 feet below the surface.

Ans.—[These seams should be worked together as one seam. On account of the total thickness of material (8 feet)] the extraction could probably be best accomplished on the room and pillar plan. In the entries the lower seam should be mined and the 30 inches of clay parting taken down. The upper seam should be left up. This upper seam of coal furnishes a good roof which not only insures clean and safe haulways and traveling roads; but so distributes the roof pressure, that the tendency of the fire clay to heave is largely overcome.

The rooms may be driven 20 feet wide, with 10-foot pillars between them. As in the entries the lower seam should be mined and the clay parting taken down in the first working. After a number of adjacent rooms have been driven up the required

distance, the work of pillar drawing and taking down roof coal is begun at the face. [This work of drawing pillars in connection with taking down roof coal is extremely dangerous, and should be carried back toward the face in two sections]. The roof coal should be first cut through along the face, [after setting rows of posts 3 feet apart and parallel to the face, for its support]. The fast ends are then cut. The coal will yield readily to wedges, [or fall at once when the posts are withdrawn. The work upon the pillars follows immediately behind the falling of the roof coal]. No attempt should be made to keep up the slate by timbering. If the retreating coal face is kept in line, there should be little difficulty experienced in removing all the coal back to the entry stumps. Should a fall occur, it is not likely that under such conditions it would extend beyond the retreating coal face.

JOHN VERNER, Oskaloosa, Iowa.

Second Prize.—JOHN FLETCHER, La Salle, Ill.

QUES. 646.—*Gas Encountered Beyond a Fault.*—In driving a heading in a level seam of coal, a fault was encountered which proved to be an upthrow. The heading was driven through the fault and then an upraise started upon the other side of the fault to find the continuance of the seam. The amount of displacement was 5 feet, and the upraise had been driven but 3 feet in the roof strata when gas was encountered. Previous to this, it had not been known that any gas existed in the seam. The ventilation of the heading was ample, a large volume of air being in circulation. A safety lamp elevated into the upraise was immediately extinguished. State what in your opinion this gas was, and explain the conditions which would give rise to such a phenomenon.

ANS.—The gas encountered was light carbureted hydrogen or marsh gas (CH_4). The phenomenon is explained thus: There is a large volume of air in circulation and as a consequence, below the level of the upraise hole, the gas is diffused as rapidly as it transpires. Above the level of the bottom of the upraise the gas is pure CH_4 , and immediately puts out a light raised into the upraise cavity.

[The fact that gas is often encountered behind a fault in working a seam not previously considered as gaseous, may be due to the fact that the disturbance that caused the faulting of the strata, destroyed their continuity and rendered the enclosing strata pervious to gas upon one side of the fault only; and the gas was thus allowed to escape on this side of the fault, while it was retained by the enfolding strata upon the other side. For this reason, it is always safer to use extra care in crossing a fault, until the character of the seam beyond has been ascertained.]

PETER WELSH, Ehrenfeld, Pa.

Second Prize.—R. ZERUBBABEL VIRGIN, Punxsutawney, Pa.

QUES. 647.—*Size, Inclination, Speed, etc., of Conveyor.*—Give size, inclination and speed of a conveyor that will lift 60 tons of anthracite coal per hour to a height of 50 feet. Describe briefly the construction of the same and give the horsepower required for its operation.

ANS.—Assume the inclination to be 30° , then the length of the trough will be $\frac{50}{\sin 30^\circ} = \frac{50}{.5} = 100$ ft. For a lineal velocity of 100 feet per minute and with flights spaced 2 feet apart, the load each flight will be required to carry is (1 long ton = 2,240 lb.) $\frac{60 \times 2,240}{60 \times 50} = 44.8$ lb. But an $8'' \times 24''$ flight will carry about 48 pounds of pea coal on a pitch of 30° and therefore fills these requirements. The horsepower required to raise a gross long ton per minute 50 feet high is $\frac{2,240 \times 50}{33,000} = 3.39$ H. P. Since the speed of the conveyor (100 ft. per min.) is equal to the length of the trough, the weight of coal in the trough equals the amount delivered each minute (2,240 lb.). The work of sliding friction for the coal will then be (since $\cos 30^\circ = .866$, and the coefficient of friction for coal sliding on iron is, say .425),

$$\frac{2,240 \times .866 \times .425 \times 100}{33,000} = \text{say } 2.50 \text{ H. P.}$$

The friction of the conveyor chain, assuming its total weight as 3,500 pounds and its coefficient of friction as .15, is

$$\frac{3,500 \times .866 \times .15 \times 100}{33,000} = 1.38 \text{ H. P.}$$

This makes a total of 7.27 horsepower, to which should be added about 10% for journal friction of chain and gearing making the required horsepower then, say 8 horsepower. At least 10 horsepower should be available to give a reasonable working margin.

For the above capacity use a double strand, drag conveyor with two $\frac{1}{2}''$ Dodge chains, one at each end of the flights. The flights should be of steel $8'' \times 24''$ with cut corners. The trough should be steel in 2-foot sections with lap joints; and should fit

flights accurately. It should be bolted rather than screwed down as screws work up and are caught by the flights.

A. B. JESSUP, Centralia, Pa.

QUES. 648.—*Form of Fan Casing.*—Describe the best form of fan casing and state how you would proceed to lay out and construct the same.

This important question still remains open, and we hope will receive the attention it deserves at the hands of some of our able men.—EDITOR.]

QUES. 649.—*Boiler Connections, Allowance for Expansion.*—In setting a nest of boilers and making the necessary connections with the main steam pipe, describe how you would provide for the expansion and contraction of the steam line.

[This question still remains open for some practical man to answer. Not a single reply has been received and the question is certainly an interesting one.—EDITOR.]

QUES. 650.—*Oak vs. Iron Tracking in Mines.*—Explain the use of oak and iron tracking, stating the conditions under which each may be used with advantage.

ANS.—The use of iron tracking is preferable in every case where it can be employed. In a remote mining region where the cost of iron rails is such as to prohibit their general use, wooden rails would be employed in the working places, and the iron reserved for the main haulways. In mines making large quantities of water strongly charged with acid which acts to rapidly destroy metal rails, wood is often employed. Wooden rails are also often used in working places, or rooms which are on a steep grade, and where a loaded car on iron rails could not be controlled even with the use of sprags, the car slipping when all the wheels are locked. In such cases the wooden rail being rough will offer sufficient resistance to the movement of the car to enable it to be handled without danger. [Iron rails represent a larger investment of capital, but reduce the operating expenses of a mine.]

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—GEO. MACPHAIL, Southwest, Pa.

QUES. 651.—*Gauge of Mine Tracks.*—What do you consider the best gauge for mine tracks; state the relative advantages and disadvantages of wider or narrower gauges.

ANS.—The gauge of a mine track should conform to the conditions peculiar to the particular mine in question. The thickness of the seam, [and the character of the roof and floor] determine in a general way the size of the haulage roads and consequently of the mine cars which pass through them. The terms *broad gauge* and *narrow gauge* are to some extent relative terms. [What would make a narrow gauge for a thick seam and large output, would be a broad gauge for a thin seam and smaller output.] The question of economical haulage considers a minimum number of cars having a maximum capacity. Since the car length is limited by the necessarily short wheel base to say 10 feet, and its height by the thickness of the seam and limit of easy hand loading, the remaining dimension or the width of the car is usually the variable factor. To obtain the maximum capacity required, the width of the car must be increased, thereby requiring a broader gauge for stability. A broader gauge reduces wear and tear on tracks and rolling stock, and requires outside wheels, which are cheap, easy to lubricate and to replace, and whose axles do not easily bend. Cars with a relatively narrow gauge run more easily around sharp curves; they are generally made with inside wheels. With wheels inside the frame, the capacity of narrow gauge cars may be made to almost equal that of cars of broader gauge; but they lack the stability of the latter. With narrow gauges shorter ties can be used, reducing the amount of cutting in bottom of thin inclined seams, and more room is available for ditching; but with a very narrow gauge too little room is given for the mules to tread, and they frequently slip on the rails and are injured, especially at curves. [The gauges of mine tracks in common use vary from 30 inches to 4 feet; the narrowest gauges are usually found in metal mines. No rule can be given that will apply to all conditions.]

A. B. JESSUP, Centralia, Pa.

Second Prize.—J. M. COWAN, West Moshannon, Pa.

"Mustard Gold."

What is called "Mustard Gold" in Australia (the term is not used, we believe, in America) covers an occurrence of very fine particles or strings of the metal, associated with clay, also in minute quantities. Under the microscope it looks like a tiny fragment of sponge, with the white clay or talc filling all the interstices. It easily yields to the pressure of a knife blade, and flattens out to a very thin leaf or yellow smudge. It is very pure metal, and is held to be an invariable indicator of gold in the condition of tellurides (as at Cripple Creek) below. In fact, the particles of mustard gold have been proven to be the result of the decomposition of the telluride minerals.—*Mining Reporter.*

MINING PRACTICE

At Rossland, British Columbia—The Methods of Development at War Eagle and Centre Star.

Methods of Diamond Drilling, Shaft Sinking, Drifting, Raising, Blasting, Trimming, Hoisting, Ventilation, Lighting, Pumping, Air Compression, Blacksmithing, Etc., and Costs.

Written for MINES AND MINERALS, by R. B. Brinsmade, B. S., E. M.

The mining in Rossland, B. C. has been in some part carried out by men who came from Butte, Montana, and were in consequence skilled in the methods there employed. The vastly different geological and topographical conditions, prevalent at Rossland, have necessitated a radically different method of developing the ore bodies and extracting their contents, from that in use at Butte City.

The geology, topography and mineralogy of the district were so thoroughly described in Prof. Lakes' article that appeared in MINES AND MINERALS for July 1900, that I will not repeat them here. The practice to be outlined is, in the main, that followed at the Centre Star and War Eagle Mines in the Spring of 1900, and is typical of the methods of the camp.

The Centre Star Mine was purchased in 1899 by the Gooderham-Blackstock Syndicate, of Toronto, Canada, and has since then been equipped with a new outfit of machinery and the development work has been so extended as to enable the mine at the present writing (November 1900) to ship 300 tons of ore to the smelter daily. Fig. 1 shows the large head frame and shipping bins of the Centre Star, in process of construction, and nearly ready for the new double drum steam hoist. In the distance appear the rough and hilly mountain country surrounding the flat basin in which the town of Rossland is situated, the western half only being shown in the photograph.

The country rock of the mines is a hard igneous formation, mostly diorite, containing the fissure and shear veins worked. The strike of these veins is approximately east and west with a dip to the north of 50 to 70 degrees. The rock is not only very dense (about 12 cu. feet in place weigh a ton) but very hard to drill, and tough to break. These facts cause a large bill for drilling and powder, but to compensate, no timbering is needed to hold up the sides or the back, all the timber used being for other purposes.

The values of gold and copper are contained in pyrite, chalcopryite and pyrrhotite, which are distributed through the pay shoots of the veins in irregular masses. Those portions stoped vary in value from \$50.00 per ton, down to the pay limit, which, in January, 1900 was about \$11.00 per ton, but has since been reduced. As yet there has been no attempt at concentration, as the friable nature of the chalcopryite renders the ordinary jigging method impractical. There is little sorting underground, as frequent assays are the only way to distinguish between pay

ore and waste, so that where rock is broken down, too low for the smelter, it is thrown on the dump.

For a young camp like Rossland it will be unprofitable to give the mine practice in detail, as was done for Butte,* but a number of items of interest to the mining profession will be noted.

Development.—The mines have been developed by running inclines along the dip of the vein, and from these inclines driving horizontal drifts at 125 foot intervals along the strike, and usually within the walls of the vein. Fig. 2 is a longitudinal section and plan showing the method of development in the War Eagle mine, it is not to scale and only a few stopes are illustrated. The centre line of the main shaft coincides roughly with the median line of the pay shoot, which extends 300 to 450 feet along the strike of the vein. The vein structure is complicated by numerous dikes and faults, that largely increase the quantity of development work necessary to extract the ore. As shown in the longitudinal section, there are many natural pillars left, containing rock too poor to break. The proportion of pay ore to the area of the main shaft varied from 42 per cent. on the 4th level to 78% on the 1st level (the ore having been exhausted only on the first four

levels). The stopes vary in average width from 5.2 feet on the 1st level, to 13.2 feet on the 5th level.

The mine was first worked successively from the tunnels on the 1st, 2d, and 4th levels. The main shaft changes from 58 to 64 degrees dip, near the 3d level. Intersecting the ore shoot are numerous dikes; and the diamond drill is employed to find the continuation of the vein, as well as to evaluate the ore bodies when discovered.

Upraises from the drifts enable the ore to be stoped by the overhand and breast methods.

Diamond Drilling.—

Two sizes of drills are used; one with a bit of 2½ in. outside and 1½ in. core diameter, and the other with 2½ in. outside and ½ in. core diameter. The machines being seldom used for borings over 300 feet deep are set on two vertical bars jackscrewed against the rock walls; and are run by compressed air from the percussion drill mains.

In starting the drill especially from those drifts in which trimming is being pursued, a short cross cut is first cut out by percussion drills to give a space for the machine, and the proper handling of the rods. Fig. 3 shows an example, where four holes a, b, c, and d have been put in, from the cross cuts cut out from the drift side.

The rods are square threaded at their ends and come in 5 foot lengths, they are pulled, in lengths of 5 to 20 feet, according to the space available behind the drill.

The holes are cored throughout. The core barrel is 5 feet long, and the frequent slips and small seams in the country rock, permit the cores procured to be easily broken off by the usual choker device. The average length of the pieces of core is 5 to 8 inches, though pieces as extreme as ½ inch, and 4½ feet have been obtained. In careful sampling, the core barrel is sometimes pulled out for every 6 inch advance.

The drilling engines are screw feed, and fitted for 300, 700 and 1,000 rev. per inch of advance. Their ordinary speed is 300 R. P. M., with a maximum allowable on the engine of 1,500 R. P. M. The water is pumped through the drill rod by a small independent boiler feed pump run by compressed air. The average

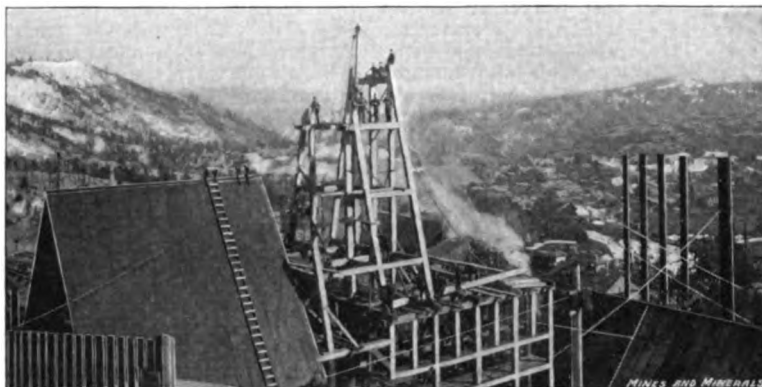
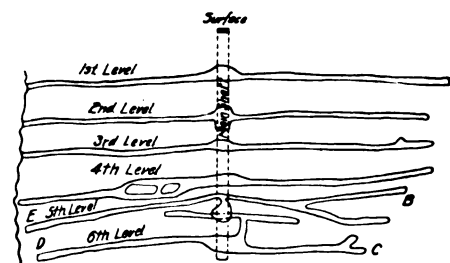
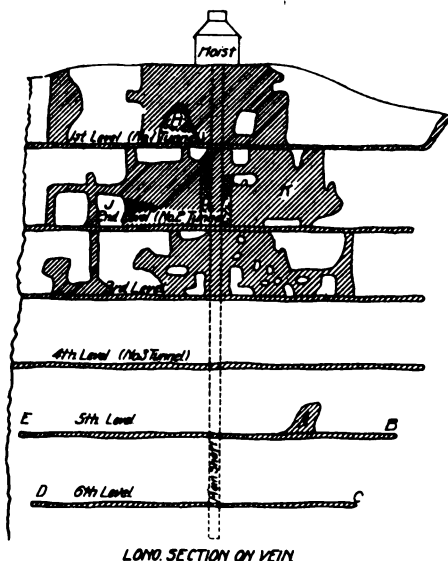


FIG. 1.—HEADFRAME AND SHIPPING BINS, CENTER STAR MINE, ROSSLAND, B. C. IN PROCESS OF CONSTRUCTION.

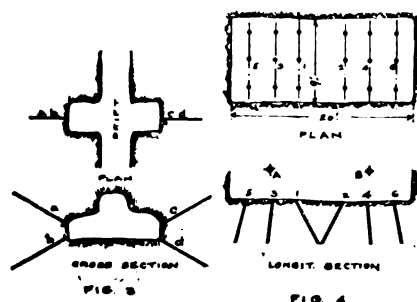


MINES AND MINERALS PLAN OF DRIFTS

Fig. 2

*See MINES AND MINERALS for October and November, 1900.

progress is 8 feet in an 8 hour shift, with a record of 18 ft. 9 in. The core is broken up and assayed, after a careful examination by the mine superintendent. While drilling in ore, sludge samples are taken by running the discharged water for a fraction of the time, into a tin pail, in which the sludge settles out. The Rossland rock is very hard on bits and diamonds; it occupies the time of a skilful bit setter to keep one drill running for 24 hours daily, and the wear of carbons is somewhat less than $\frac{1}{4}$ carat per foot of hole drilled. Each bit will only drill about 12 feet before



resetting is necessary. By skillful setting, reaming the hole for a new bit is generally avoided, but is sometimes necessary for the last few feet. For the shallow holes drilled, an application of screw jacks will usually start a bit that is stuck. To recover a bit that has been broken off in the hole, it is necessary to ream out the hole with a new bit large enough

to enclose the stuck bit and recover it in the core barrel.

Diamond Drilling at Butte, Mont.—Butte practice varies very little from that of Rossland. Deeper holes are common requiring machines of 1,000 feet capacity. These machines rest on their own frames, the columns being omitted. As the rock is softer, faster drilling than in Rossland is possible; 14 feet per shift is often obtained as a monthly average on holes 500 feet deep. One bit will last 40 feet in granite country rock, and 25 feet in vein matter before resetting is necessary. For the longer holes the drill rods are in 10 feet lengths, and 30 feet of rod is sometimes pulled at a time. Ten foot core barrels are also used for quick work. The common size of bit is $1\frac{1}{2}$ inches external, and 1 inch core diameter. The Butte drill runners work ten hour shifts, which accounts in part for the greater advance per shift. The cores according to the common practice are stored in long core boxes of 1 inch pine and properly labeled.

Shaft Sinking.—The Centre Star Shaft is $18'4'' \times 7'$, out to out of timbers, and is on an incline of 70 degrees. Fig. 4 shows the position of the drill holes for sinking. The whole round is drilled before any blasting is done, the machine drills being set up at A and B. Two machines with 4 men work at once, and it usually takes 2 shifts to drill the round of 18 holes, for very hard rock as many as 3 extra holes are sometimes put in the cut. After the round is drilled the cut of rows Nos. 1 and 2 are loaded and fired, then (as the shaft is practically dry) the debris is mucked and hoisted. Afterwards the end holes are loaded and fired in the order of rows Nos. 3, 4, 5, 6, and when the rock from these is cleaned up the round is completed. The machine men do all their own blasting and loading, as it is impractical to have a separate gang for blasting in the shaft as is now the system in the stopes and drifts (described under "Labor Conditions"). The amount of powder used per foot of a 9 ft. $\times$ 20 ft. shaft sunk was 25 lb. of No. 1 dynamite as the average for a recent period.

The rock is hoisted during sinking by a bucket let down from a sheave in the ladder compartment, by a small Bacon timber hoist in the station above. The only timbering put in during sinking is the temporary skids on the foot wall on which the bucket slides. These skids are of round poles, 6 inches in diameter, and are held firmly in place by spiking them to sprags, whose ends are wedged into holes cut into the shaft walls.

The former custom was to leave a rock bulkhead, below the two hoisting compartments, at the level above. When the shaft had reached the next level, timbering was begun from below and lined in by a transit through the hole of the ladderway, the rock bulkhead being knocked out last of all. This method has been abandoned in favor of the timber bulkhead (as used in Butte). By this method the timbering goes on contemporaneously with the sinking, sufficient space being left to keep the lowest set from being injured by the heavy blasts. This clearance is 20 to 25 feet above the sump.

In timbering the shaft the shaft sets are of sawed yellow (Northern) pine, framed on the surface, and are placed 5 feet apart, being separated by posts. The only lining used is 2 in. $\times$ 12 in. planks placed on the hang wall sets, to keep large pieces of rock from falling into the skip.

Drifting.—Where possible, the drifts are driven along the hanging wall, so as to have one free face to break from. As drifting here requires no timbering, and is in equally hard rock, it is mechanically the same as cross-cutting and the two will be considered together; though drifting, when along a vein wall, makes quicker progress.

Fig. 6 shows the position of the drill holes in drifting. Twelve holes are now used instead of 15 holes as formerly; the latter number insured a better squaring of the section but was unnecessary and expensive. Rows 1 and 2 are loaded and fired, then rows 3 and 4 are loaded and fired. With the drill bar set vertically as at d, all these holes could be drilled without changing the bar; but with three shifts in 24 hours that insured continuous working, it was usually impossible to clear the muck away fast enough to make room for the vertical setting; so that the horizontal setting was employed, necessitating 3 changes, at c, b and a.

The advance per round of holes is about $3\frac{1}{2}$ feet. 60 per cent. dynamite is used for primer cartridges, and 50 per cent. for the balance of the explosive. 40 per cent. dynamite is employed if soft rock is struck. It takes 30 per cent. more powder for the top holes than for the cut. $10\frac{1}{2}$ pounds of powder per foot advance, was the average consumption for a recent period. The grade of the drift is about $\frac{1}{4}$ of 1% and the drainage runs at the ends of the track ties. The speed of drifting varied from 60' to 100' per month with one drill, working 3 shifts per day and every day in the month. The shifts were $7\frac{1}{2}$ hours net, $\frac{1}{2}$ hour being allowed for lunch—unlike Butte where the miners and muckers underground have the same pay, the muckers and trammers here receive only \$2.50 and the machine men \$3.50 per shift. It is therefore more economical to keep the machine men constantly drilling, and leave the loading and tramping to the muckers. This system was pursued in the above figures.

No timber except the track ties is put in while driving the drifts.

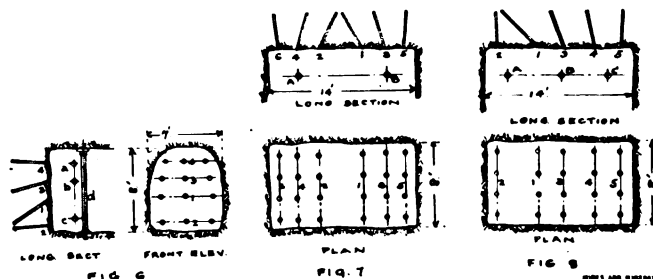
Raising.—The raises are put in at irregular distances along the drift, and at least 50 feet apart. There are usually two compartments, one a manway, and the other an ore chute. The old method of drilling is shown in Fig. 7, this took 24 holes. The center cut, rows 1 and 2 were first loaded and fired; and then, rows 3, 4, 5 and 6. The round was completed with two set-ups of the drill bar at A and B. The present method requires but 20 holes, Fig. 8. Cut rows 1 and 2 are blasted first, and then rows 3, 4, and 5. This system was introduced by Mr. Davis the mine superintendent; it takes 16% less drilling and saves powder.

For drilling the back in the raises the men stand on a temporary platform of sprags and 2 inch plank, that is pulled down before every blast. The permanent timbering is kept within 15 feet of the back. The drills used are No. 2, Rand pattern, throughout the mine, and are set on a bar placed at right angles to the hangwall of the raise. The bars of extra heavy hydraulic pipe can be used for spans of under 13 feet.

Fig. 9 shows the timbering of the raises. The manway is partitioned from the chute by 2 in. $\times$ 12 in. planks nailed onto the stulls by 6 in. wire spikes. A double bulkhead is put in every 12 or 15 feet to prevent rock from blasting, falling into the manway. During blasting the drill is kept on the topmost plank bulkhead. Often the plank bulkhead is removed after the double bulkhead above has been put in.

The stulls are round pine (barked) of 10 in. to 16 in. diameter. They are set about 10 degrees upwards from a perpendicular line to the hangwall, hitches being cut out for them in the walls, and the stull ends wedged tightly into place. The lag poles are unbarked fir or black pine, and they are spiked to the stulls. The chute gate is made by spiking 2 in. $\times$ 12 in. plank to two vertical posts set in the drift below, and by putting between these a double plank gate as in Butte practice.

Narrow Stopes.—The method for the narrow stopes (under 13 feet wide) of which the greater part of the workings consist is



illustrated in Fig. 10. Having carried up the raise a sufficient height, stoping begins at the lowest limit of the pay ore as A and the stope CD is then driven to boundary of pay shoot. Round stulls (the same as in raising) are then put in, and a close floor of lag poles spiked onto the stulls. Stopping above the floor then commences, and the space E is excavated.

The ore broken is kept up close to the face for the machine men to work from and the number of floors vertically, depends upon the need of ore for shipment and the convenience of working;

sometimes 30 feet is left between floors. The floor poles are taken up as soon as the floor above is put down, unless needed for convenience in climbing to the working face. The broken ore that will not slide by gravity into the chute, is sometimes shoveled into temporary inclined wooden troughs leading to the chute, or else pushed in wheelbarrows thither, on a plankway.

When the pay ore begins just above the drift, a raise need not be kept ahead for the whole back can be worked as a stope.

In this case there is a permanent tight floor left above the drift. The blasts in stoping are very heavy, nearly $1\frac{1}{2}$ pounds of powder per ton of ore stoped having been a recent average.

Wide Stopes.—As it is not practical to use the drill bar for stopes over 13 feet wide, some other stoping system has to be devised for wider stopes. An interesting case is illustrated in Fig. 11. The drift was originally driven at *d*, and a narrow stope with *d-l-m* as its hanging wall, was taken out above it. Along *l-k* was a slip,

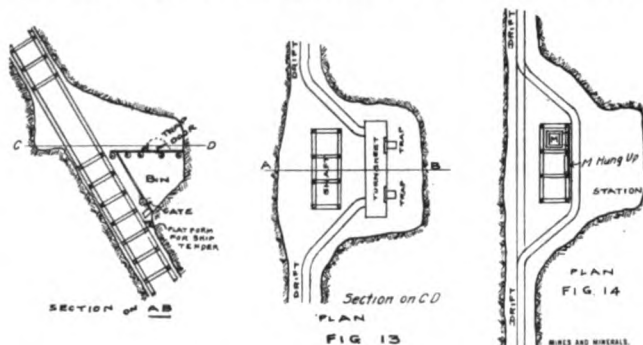
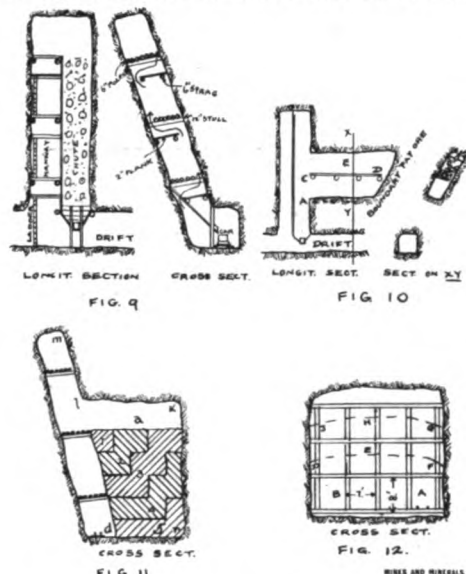
and it was found that the whole body *l-k-n-d* would pay to extract. A horizontal breast stope *a* was then run to *k*. Underhand stoping was begun, and the slices *1, 2, 3, 4*, and *5* were successively taken off, the broken ore being slid off onto the floors, and thence shoveled into the neighboring chutes. Each original stull floor was removed as the excavation reached it until the whole ore body was cut out to the level of the sill floor. The drills were set on tripods, the holes were 5 feet deep, and as many as 100 holes were blasted on the bench at one firing.

The square set method has, however, been adopted for a permanent system for the wide stopes of the Centre Star as it has also been in the Le Roi and it is worked as shown in Fig. 12. The drift *A* having been driven the breast stope *A-B* is then completed to the height of the curve *D-E-F*. Then square sets (of round pine timber, 12 inches diameter and framed on the surface by the Butte system) are put in and floored over with round poles, as in the narrow stopes.

The drill columns are then set vertically between the back, and a temporary scaffold or a pile of broken rock as a base, and back stoping is pursued to curve *J-H-G*, when the next floor of square set timbers is inserted. Enough space is always first excavated above last floor put in to give room for drilling the back. For a change in width of the ore body the stope can be extended by attacking the breast, or as many sets left out as are necessary. The broken rock is taken by wheelbarrows to chutes boxed in among the sets at 50 feet intervals and debouching above drift *A*,

or above a feeder track laid out at right angles to *A* if the stope is very wide. This is similar to the system pursued in the wide veins of Butte, with the exception that the timber in Rossland is used as a platform for drilling and loading, and has little function as a support to the roof.

Blasting.—For cleaning out downward drill holes for loading, a straight blow pipe made of 1 inch pipe is used; this pipe has at its top an elbow from whence it is coupled to the hose of the air drill. The tamping for uppers is usually small stones wrapped in paper, as there is no clay underground. The powder is kept in a small house near the railroad and a thawing temperature is maintained therein by hot water pipes heated by a stove in an adjoin-



ing cabin. A powderman watches the powder house and keeps account of the powder distribution. There is a powder boy per shift in each mine, who takes supplies to the various working faces, shortly before blasting time. In the mine workings above the lowest tunnel it is, in winter, nearly as cold as on the surface, and the powder, if left long before firing, would soon freeze again.

Tramming.—The shaft stations are untimbered, and the shaft sets are supported by large stulls set at right angles to the hanging wall above and below the station. The wall plates of the shaft sets facing the station are left out for a height of 20 feet towards the station, and posts 20 feet long are employed there on the shaft sets.

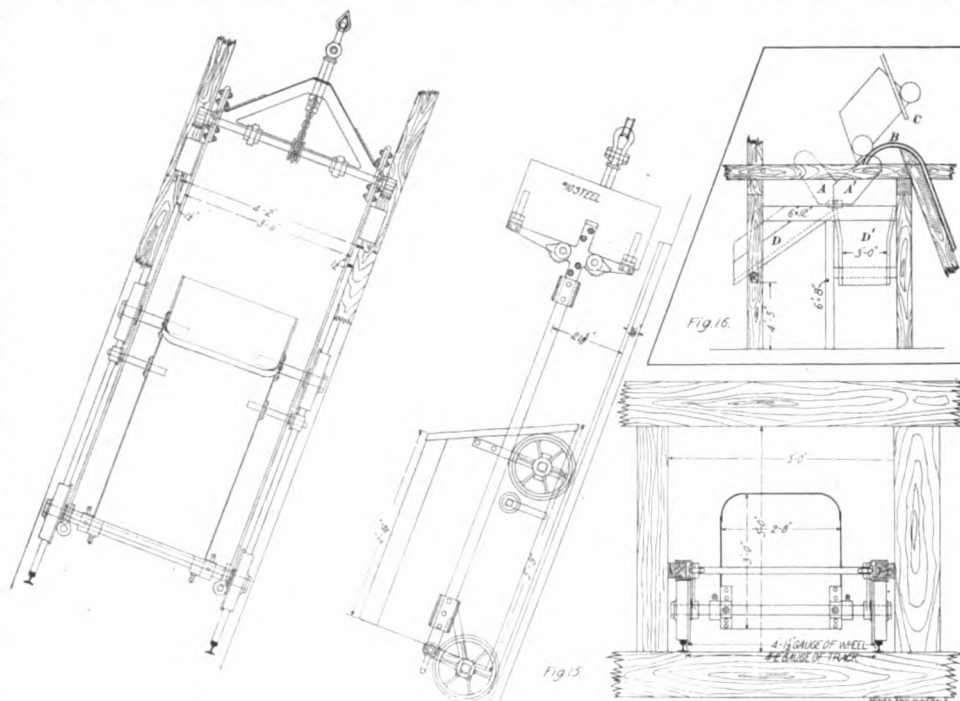
Two types of station are in use, one with a shaft bin, Fig. 13,

and one from which the cars are dumped directly into the skips, Fig. 14. In the latter case, the full car goes along the track, and when it arrives opposite the skip, the car is revolved 90 degrees on its turntable and dumped into the skip. The hinged steel hopper *M* prevents the rock from falling outside the skip, when dumping the car. At the 200 foot level of the Centre Star, turnsheets as in Butte practice have been put in with good results. A lessening of the number of cars required for tramming is the only thing gained by the installation of station bins in a self sustaining formation like this.

The tracks are

15 lb. per yard and are spiked in the drifts to ties $2\frac{1}{2}$ feet apart. The switches are made by hinging a rail at the point of the frog, the other end being split—a common type. No horses or means for mechanical haulage are used underground.

The company's own standard mine car is only 2 ft. $11\frac{1}{2}$ in. from track to top of body being especially designed so that the top shall be as low for loading as the capacity of 16 cu. ft. of rock



will admit. The turntable on the truck allows it to be dumped in any direction, and the axles are roller bushed of the Anacosta type.

Hoisting.—At the War Eagle main shaft there has recently been installed a steam hoist, made by Webster Camp & Lane, Akron, Ohio, with two drums each 6 ft. $\times$ 3 ft. with a capacity of 1,700 feet of round rope of $\frac{1}{4}$ inch diameter. The average winding speed is 800 feet per minute, with a maximum of 900 feet. All the motions are controlled by hand levers, except the steam drum brake. The engines are 14 in. $\times$ 18 in. stroke with a Stevenson reversing gear. A Lane friction clutch permits of either drum being run independently of the other; a necessary thing where there are several levels from which hoisting is done. The Centre Star put in a duplicate of this engine at its main shaft.

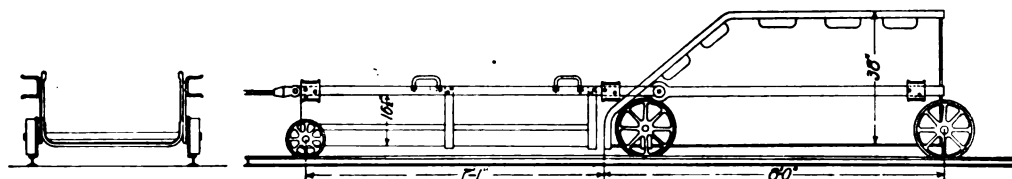


Fig. 17

The round rope is prevented from cutting the foot-wall shaft timbers by rollers on the wall plates at long intervals. A flat rope would be impractical in an inclined shaft.

The skip employed is detailed in 2 views (Fig. 15), it runs on a 30 lb. per yard steel track spiked to the foot-wall plates in the shaft. The shaft guides are chiefly for safety purposes, for the skip dogs will grip them in case of accident to the rope, as in vertical shafts. The guides also serve to keep the skip steady, as the skip body is only fastened to the frame on the rear axle.

Weight of skip 2,400 lbs.
Load of ore 4,600 lbs.

Total weight without rope 7,000 lbs.

It is proposed to increase the hoisting capacity when it becomes necessary, by attaching a cage under the skip as at the Never Sweat mine in Butte. The method of dumping the skip at the collar of shaft is shown in Fig. 18. The upper wheels of the skip run over on the bent rail *B*, while the lower skip wheels being held by the shoes to the wooden guides continue upward until they rest on the continuation of the rails at *C*, when the skip is dumped. By moving the swinging gate from *A* to *A'* the stream of dumping rock can be diverted from chute *D* to chute *D'*.

For lowering the huge stulls and shaft sets in the shaft, a special timber skip, Fig. 17, is soon to be installed. At each shaft station there is a small crane to unload the stulls from the skip in the shaft, and it has proved to be a great labor saving device.

The War Eagle steam hoist replaced a 300 H. P. electric hoist run by the current brought into Roseland from Bonnington Falls, B. C., 30 miles away. This electric hoist was a failure owing to bad design and faulty construction. In the summer of 1899 the braking apparatus failed, so that the skip unwound the rope and fell nearly 800 feet to the shaft bottom. There were 5 men on the skip at the time of the accident, four of whom were killed. The fifth man escaped almost uninjured physically, though his nervous system was nearly shattered by the awful experience. The next winter, he enlisted in the Canadian contingent for the Transvaal war; thinking perhaps, that after such an escape, a war would be no more dangerous for him than a picnic for an ordinary mortal.

A good example, however, to show that an electric hoist of correct construction will work acceptably, is the one recently installed at the Josie shaft of the British-American Corporation, made by the Denver Engineering Works. It is 150 H. P. with an average consumption for counterbalanced hoisting of 60 H. P. It works at a potential of 250 volts with a three-phase motor; and has two drums each holding 1,000 feet of rope.

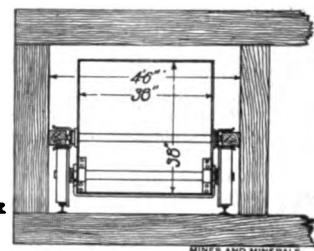
The hoisting signals are a modification of the Montana code, and the combination of the pull rope and the electric bell as in Butte is used.

Ventilation.—In the War Eagle mine there is a fine draught above No. 3 Tunnel Level, Fig. 2, the main shaft acting as an upcast in winter and as a downcast in summer; but on the 5th and 6th levels (below the lowest tunnel) the ventilation is more difficult. Where the stope is holed through into the drift above, there is more or less of an air current even though there are no

steam pipes in the main shaft to make it a strong upcast as in the Butte mines. But in the uncompleted stopes as *A* and the long drifts *B*, *C*, *D* and *E* artificial ventilation is needed; especially in the stopes where the vast quantity of powder fired at one time would blockade them for many hours, if there were no strong draught to clear the air.

A Root blower on the surface blows a positive current down a main, set in the ladderway of the main shaft. This main is round, of galvanized steel, and is riveted and soldered with telescope joints. Branches of smaller piping are taken off at each level, where necessary, and led to the working faces.

Light.—The tunnels are lit throughout by 16 c. p. lamps, furnished with horizontal tin reflectors painted white on inside and black outside. At the working faces candles are used.



Pumping.—As yet the water encountered is insignificant in amount and non corrosive. In sinking the Centre Star mainshaft below the 3d level, a small boiler feed pump was set on the shaft bottom that threw a stream to a wooden tank placed just below the 3d level. A sinker pumped from this tank to the 2d or adit level. The water column was a butt welded 3 inch diameter pipe with sleeve coupling; and both pumps were driven by compressed air.

Air Compressors.—At the War Eagle hoist is a 200 H. P. forty drill compressor run by an electric synchronous motor. The synchronous motor has worked badly for the great changes of load on the air system throw it out of "step," causing a stoppage. These stoppages at first caused long delays owing to the small starting motor; but since the installation of a large polyphase induction motor for starting, the synchronous motor can be brought up to speed and started with small bother.

At the Centre Star mine a compressor of the same size has been put in, to be driven interchangeably by electricity or steam. A feature unusual in Western mine practice is its condensing system. The exhaust steam is passed through a surface condenser by a vacuum pump and is thence forced back into the boilers by a boiler feed pump. The condenser cooling water is passed over a cooling tower, and returned to the vacuum pump (the circulation being performed by a separate pump). The cooling tower is a series of horizontal troughs (of wood and galvanized steel) that expose the water in thin sheets for partial evaporation in the atmosphere, by which the residue is cooled.

Blacksmithing.—There is no hand drilling done except by the timbermen to cut hitches for placing stulls and sprags, and the hardness of the rods renders picks of little use. There remains little to be sharpened but machine bits, which are made (as in Butte) by welding a star steel point to an octagon steel shank. They are + points with the cutting edge including an angle of 70 degrees. They are tempered by heating them in batches (after sharpening and cooling slowly) to a dull red and plunging in water. The hand steel and picks have their temper drawn to a straw color. Each machine drill drills from 20 to 30 bits in 8 hours.

Headframes.—At the War Eagle is a large structural steel headframe, very expensive as it was imported from the Eastern United States necessitating not only heavy freightage, but a high import duty. Hence the new frame at the Centre Star mine, 72 feet from the base to the center of the sheaves, is entirely of wood, Fig. 1; the timber of the Pacific slope being peculiarly adapted for this purpose on account of its great size and strength, and ease of framing.

The hoisting engine is set on the hang wall side of the inclined shaft; this simplifies the head frame, as the posts in the direction of the shaft act as back braces for the frame.

Surface Tram.—To transport the ore from the main shaft down to the shipping bins at the railroad, the War Eagle employs a double track gravity tram. This tram is set for nearly its whole length on a trestle, not only to save grading, but to escape the effect of the snow fall, which in Roseland, is sometimes 5 feet on the level, before spring. The tram has a fall of about 350 feet in a total length of 1,300 feet, and in profile, has a concave and a

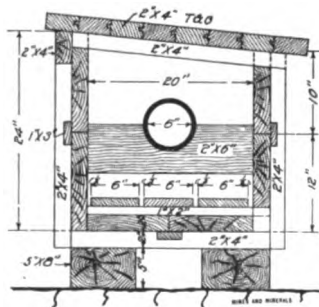


Fig. 18.

convex curve. The rope is kept down on the concave curve by a pulley in an overhead frame, and kept up on the convex curve by a sheave of 4 feet diameter set between the tracks.

The tram car holds 5 tons of ore, and is dumped automatically at the lower end of the tram. The wheels on the car body run up on tripping tracks set at the sides of the car and turn the whole car about its front axle. At the same time the tripper releases the catch on the front door of the car, and the door opens to pour the load of ore into the chute on top of the shipping bins.

At the upper end, the tram cars are controlled by two horizontal sheaves in tandem, around which the rope is wound twice, the upper sheave being provided with two band brakes. One engineer controls the brakes and loads the tram cars for the descent.

Steam Line.—An interesting innovation is the transmission of steam through a 6 inch pipe from the boiler house at the Centre Star, up the slope of the hill for nearly 1,500 feet to the War Eagle shaft house. Fig. 18 shows a section of the wood box enclosing the pipe, the pipe being set well above the bottom to allow for drainage and packing. The interior of the box is filled with dry coal ashes to serve as packing. The necessary condensation is drained by 4 steam traps set at intervals along the pipe. A number of anchors hold the pipe in place at the bends. When on the surface the box is naked; but for part of its length it lies underground and is there enclosed in a wooden conduit large enough to permit the free entrance of men for repairs.

The writer has no figures for condensing loss in this steam line; but well covered and drained as it is, it is undoubtedly more economical than to haul coal by wagon up from the railroad to be consumed in a separate boiler plant at the War Eagle Hoist.

Buildings.—Western mining camps are built as a rule for purposes of strict utility nothing of the beautiful being attempted either for company buildings or individual residences. Rossland, however, is an exception. The War Eagle Hotel Company has built for the mine employees a hotel, that in exterior and inside appointments would do credit to an Eastern city. The offices, and houses for the officials, of the British American Corporation farther down the hill are also very tasteful, while numerous charming private villas are situated in the town itself.

Working Costs.—A commendable feature of the War Eagle-Centre Star management is the detailed report issued annually to the shareholders. An example which might well be imitated by many of our American mining companies, whose policy of secrecy makes investment in their properties largely a gamble. In this annual report are shown not only the general financial balance sheets, but the condition of the mine as to ore reserves, and the itemized cost of each branch of the work.

Following is a table of itemized costs in the War Eagle Mine for the 12 mos. ending Sept. 30, 1899.

	Development Work.			Ore Extraction.
	Sinking Main Shaft.	Raising.	Drifting.	
Total advance, feet	1224	417	1884	
Ore stoped, tons				45,810
Cost per foot.				Cost per ton.
Drilling	\$52.55	14.01	8.45	1.58
Tramming and shoveling	4.22	4.06	3.10	.53
Timbering	23.22	3.16	.07	.29
Hoisting	9.72	.15	.20	.13
Smithing	5.18	1.88	1.21	.15
Ore sorting	0.74	.14		.01
General labor	10.04	3.36	2.39	.30
Air	7.32	2.76	1.55	.21
Candles and illum. oil	.95	.40	.27	.08
Lubricating oil and waste	.75	.22	.14	.02
Explosives	5.25	3.22	1.87	.25
Drills and fittings	1.71	.52	.26	.05
Mine supplies	1.61	.49	.85	.04
Lumber expense	.74	.45	.32	.03
Stable and teaming	1.19	.42	.28	.04
Assaying	.54	.40	.19	.05
Surveying	.90	.28	.18	.02
Electric lighting	.74	.40	.28	.03
Salaries	4.07	1.76	1.21	.18
Office expense	.38	.14	.08	.01
General expense	1.10	.56	.38	.05
Total	132.92	38.78	22.78	3.95
Total cost mining per ton ore stoped				5.86

In the above table the large cost for total drilling and explosives and the small expense for timbering (except for the mainshaft) is especially noticeable. Results due to the hard self sustaining character of the rock as previously noted. The proportional cost for development per ton of ore sold ($= \$1.91 \div \$5.86 = 33$ per cent.) would be large for a Lake Superior Iron Mine, but

small in some of the narrow-vein gold and silver mines of the Rockies.

Labor Conditions.—Rossland is a union town, the local miners' union being a branch of the Western Federation of Miners.

The scale of wages for the leading positions was:

Shift boss	\$ 5.00	Machinists	\$ 4.00
Shaft men	4.00	Blacksmiths	4.00
Machine men	3.50	Helpers	3.00
Timbermen	3 to 3.50	Hoisting engineers	3 to 4.00
Shovellers and carmen	2.50	Powder and tool boys	2.50
Carpenters	3.50	Surface laborers	2.50

The surface men work ten hour shifts except the carpenters, who work nine. On May 1st, 1899, the provincial 8 hour law went into effect that allows underground labor of all kinds to work but eight hours. At first, at the War Eagle Mines, this was applied by putting on 3 shifts in 24 hours, which reduced the actual working time of the men to 7½ hours as ½ hour was allowed for lunch. This was a wasteful arrangement, as in spite of the power blowers for forcing out the smoke after blasting, such huge charges as were used to break the rock rendered sometimes a stoep unapproachable, thereafter, for several hours. An air drill was necessarily often idle also to permit the machine men to load, blast, and then clear the muck away sufficiently to set up again.

In the Spring of 1900, the 3 shift system was abandoned in favor of the two shift, arranged thus: The first shift started at 7 A. M. and worked with an hour's intermission till 4:00 P. M. The second shift started at 4:00 P. M. and with an hour for supper at 6 P. M. finished at 1 A. M. From 1 A. M. to 7 A. M. a special blasting gang loaded and fired all the ground drilled for breaking. By this method the working faces were freed from smoke before the machine men started work at 7 A. M.

As the ore bodies of Rossland are wide and homogeneous and the rock in general offers an equal resistance to drilling, it was found practical and desirable to put the machine men on the contract system to stimulate them to utilize the air drills to the best advantage during the short 8 hour shift. As the companies did not wish to allow subcontracting, and it was expected that the machine men's time would be utilized entirely for drilling—the contracts were let on the basis of a price per foot of hole drilled, instead of by the foot of drift or shaft advanced, or by the cubic yard of stoep excavated, as is customary in other camps where the contract system of mining prevails.

The contract system was inaugurated by the companies after a shut down of several weeks, and the miner's union at first declared against the change. After a conference of several days, between the mine managers and representatives of the miners, in which the Dominion Labor Commissioner and two provincial officials assisted; a mutually satisfactory agreement was reached and the contract system has been in successful operation ever since. It would be interesting to give comparative results between the contract and the former day's pay system; but they will not appear till the publication of the next annual report by the companies' directors.

At Butte, Montana, the contract system was tried for stopping some years ago in one of the mines but proved a failure; as the variable nature of the rock, and the careful sorting required before tramming, necessitate the exercise of carefulness as well as mere speed.

In the Slovan District, B. C., where the mines are best worked by the day's pay system, the 8 hour law was followed by a 7 months' strike, before a working compromise could be reached as to the rate of wages for the shorter shift. So that the idea of the contract system at Rossland proved a happy one, as both miners and operators were by it, saved from the great losses attendant upon an industrial war.

In spite of the great recent fall in the market prices of some of the Rossland stocks, there is more work going on and more ore being shipped from the camp than ever before. Boom conditions of the early nineties have passed away, but the vast low grade ore bodies now in sight, and the extensive improvements in mine equipment and labor organization, coupled with the greatly decreased smelting charges at Northport, Wash., and at Trail, B. C., render the future a very hopeful one.

Coal in Rhodesia.

Rhodesia has, as yet, no producing coal mines of its own. The coal seams are there, however, and within a year or two some of them will have been opened up. The coal is situated principally in the Wankie and Tuli districts, and it is also known that there are carbonaceous deposits along the southern bank of the Zambesi and elsewhere. Until such times as the means of transport in Rhodesia are greatly improved Zambesi coal must remain outside the economic pale, and it is to the Wankie and Tuli districts—principally to the Wankie—that the country must look for its future supply of fuel.

"Atlas" Pipe Wrench.

The Atlas Pipe Wrench Co., 121 Liberty street, New York, is manufacturing the "Atlas" pipe wrench, here illustrated. Every part of the wrench is made strong and will stand hard usage. It is made of a special wrench steel, drop forged, and every wrench is tested. The movable jaw is not a screw jaw. There are no nuts on this device to jam, and there are no delicate parts to get out of order or break. The movable jaw, as shown in the illustration, is in slot 3, which is for the larger sizes of pipe. By



shifting to slot 2 the wrench can be used for medium size pipe, and shifted to slot 1 it can be used on smaller sizes. For example, on the 18-inch wrench slot 1 is for $\frac{1}{2}$ to 1-inch pipe, slot 2 for $1\frac{1}{2}$ and 1 $\frac{1}{2}$ inch pipe, and slot 3 for 2-inch pipe. A set of four wrenches will handle all sizes from $\frac{1}{2}$ -inch wire to 4 $\frac{1}{2}$ -inch pipe. In the illustration herewith, which is an 18-inch wrench in operation on a 2-inch pipe, it will be seen that the teeth grip the pipe at an angle, and the gripping point is far in advance of the handle, showing that in screwing a pipe the operator is pushing it ahead, and that the tool does not dig into the pipe and drag it, thereby preventing crushing the pipe. The makers also state that this wrench will not lock on a pipe. It is supplied in four sizes, 10, 18, 24, and 36 inch lengths when open.

TRADE NOTICES.

The Boston & Lockport Block Co., manufacturers of tackle blocks, office 142 Commercial Street, Boston, reports that the year and century are opening up finely for the block and truck business. There seems to be a great deal of activity in large enterprises which require blocks of the largest capacity; and this company is making and sending out more specialties than ever before. The year just closed was by far the largest and best ever experienced by this well known company.

The Burt Mfg. Co., of Akron, Ohio, were recently favored by an order for two 150 gallon Cross oil filters to equip the new modern power house of the Havana Street Railway Co., Havana, Cuba. As only the best, most modern machinery was selected, this is a strong endorsement in favor of their filter.

The Williams Patent Crusher and Pulverizer Company, 2701-2707 North Broadway, St. Louis, Mo., reports that the outlook for the celebrated Williams coal crushers is better than it has ever been before. Numerous testimonials from users of these crushers testify to their worth and the excellent results which are being obtained with them.

Messrs. Hughes & Bros., 420 North Main Ave., Scranton, Pa., manufacturers of safety lamps, anemometers, etc., report that their shops are being worked to their fullest capacity and that they are scarcely able to take care of the orders that are coming in. This work includes orders for safety lamps from all parts of Pennsylvania, from Indian Territory, and in fact every part of the United States.

John Muirhead & Son, of Pittston, Pa., contractors for prospecting mineral lands with the diamond core drills, and agents for Pennsylvania of the M. C. Bullock Mfg. Co., advise us that since the establishment of the company in 1869, it has drilled 375,000 feet or about 71 miles of test holes, artesian wells and holes for other purposes. The largest hole drilled was 24 inches in diameter, which was afterwards reamed out to 36 inches, while the deepest hole was 2,580 feet.

Messrs. Witherbee, Sherman & Company, Inc., have appointed Messrs. Pilling & Crane, of Philadelphia, exclusive Sales Agents of their various grades of iron ore, and bespeak for them a continuance of past patronage.

The grades of ore to be shipped this year will include "Old Bed 21" lump, furnace and open hearth basic; also, high grade concentrates, which will be produced by crushing the ore to a coarse mesh, eliminating most of the phosphorus and materially increasing the yield of metallic iron. It will not be fine enough in physical condition to be objectionable in the blast furnace. Pilling & Crane, Girard Building, Broad & Chestnut Streets, Philadelphia, have established branch offices at No. 56 Pine St., New York, in charge of Mr. Lewis W. Francis, for the transaction of a general ore, iron and fuel business.

The Ball Engine Company, of Erie, Pa., has recently received

the following letter in regard to the Ball engine installed in Machinery and Electricity Building of the Paris Exposition:

BALL ENGINE COMPANY,
MR. D. N. MCBRIER, Vice-President,
Erie, Pennsylvania.

Dear Sir:—The end of the exposition having arrived I feel it my duty and privilege to inform you, officially, concerning the operation of the 300 H. P. tandem compound engine, which you supplied this department for the operation of the power generator at the United States Machinery Building, at Vincennes. Our plant was the first of the entire exposition to be put in active service and since the starting of your engine we have never had a moment's shut down or the least difficulty which could, in any way, be traceable to your engine. It has operated noiselessly and continuously and has made many friends among the foreigners who have visited the plant. I must congratulate you upon the workmanship and execution, in all directions, of the engine, as was evidenced by the fact that we procured for you at the hands of the International Jury of Award a Gold Medal which is an exceedingly high honor for an engine of this size and class.

I must again thank you for your many courtesies, and the promptness with which you dispatched the engine.

Yours very truly,

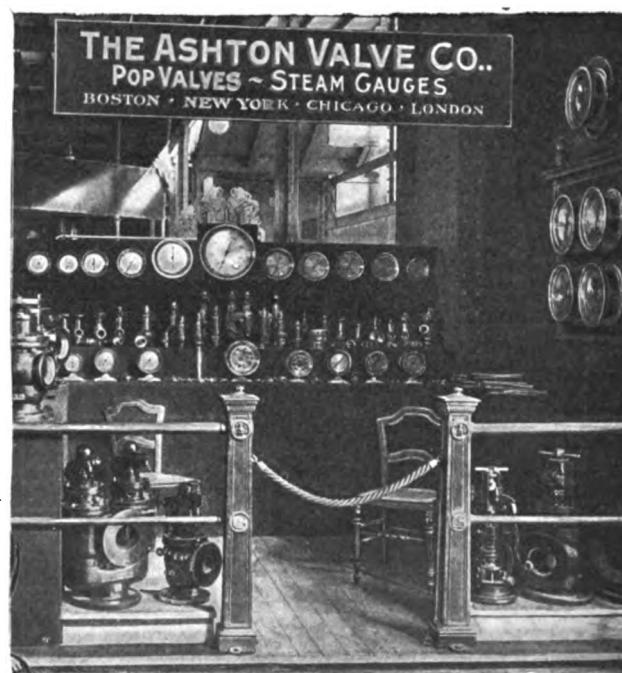
F. E. DRAKE,

Director of Machinery and Electricity, United States Commission to the Paris Exposition of 1900.

The Ashton Company's Exhibit.

The accompanying illustration shows the exhibit of valves and steam appliances of the Ashton Valve Co., Boston, Mass., at the Paris Exposition. The display is complete and effective, consisting of the entire line of goods as shown in the company's catalogue, which includes pop safety valves for locomotive, stationary or marine boilers, cylinder relief valves for steam engines, water relief valves for pumps, and pressure and vacuum gauges of every description. The exhibit was located in the Palace of Machinery, Champs de Mars, United States Section.

The Ashton Company had another exhibit in the United States Department of Varied Industries, Heating and Ventilating



Section. This one was not so extensive as the former, but it shows mainly the same class of goods and such as are used in low pressure work as required in steam heating plants.

The Jury of Awards of the Exposition have awarded to the Ashton Co. three medals on account of the excellence of these exhibits. One of these is of silver and two of bronze. The silver medal being the highest award possible to obtain.

The representative in charge of these exhibits was Mr. Alexander Kiatibian, a man especially fitted for this work, inasmuch as he is a resident of Paris, and can speak seven languages fluently. He graduated with high honors and the degree of B. A. from Kings' College, London.

ELECTROLYTIC PROCESSES

For Gold Extraction—Some of the Methods Which Have Been Proposed and the Difficulties Met in Their Operation.

Written for MINES AND MINERALS by Alfred T. Weightman.

Ever since the phenomenal success of the MacArthur-Forrest cyanide process, and even before then, epidemically, processes have been brought out for introducing the assistance of electricity for dissolving and precipitating the gold, none of which, so far as the writer is aware, have been a permanent success, or have stayed with us for any length of time.

The first necessary condition for any wet process for gold extraction is that it shall be able to extract the gold from an ore which ordinary amalgamation will not touch and must not be considered for a moment as being competitive with amalgamation, the latter being so very cheap and simple that it can easily hold its own from a question of cost against any wet process. In fact it must be considered as a process for the treatment of tailings, concentrates, or refractory ores and not for free milling ores. In this case, therefore it has invariably to deal with baser metals which are present in quantities far larger than the gold itself and unless there is a selective action so that the gold is attacked in preference to the other metals, the process will have little or no opportunity of success. If this selective action for gold were not present all the baser metals would have to be first attacked before the gold would be acted on with the result that the cost of chemicals would eat up all profits.

The possibility of the successful electrolytic extraction of gold looks exceedingly well on paper and perhaps this is why so much time and money has been spent over a method which has actually, if carefully considered in detail, little chance of success. The earliest method tried was to generate the chlorine by passing a current through a solution of NaCl or sometimes NaBr containing the ore, usually kept in a state of unrest by some form of agitation, the various patents merely constituting different details of construction. It is difficult to see why the patentees should expect chlorine generated electrolytically to possess any magical properties or in fact to differ from chlorine generated in any other way. It may combine with the NaHO generated at the negative pole to form hypochlorite of sodium (NaClO) but this is rather a retrograde step. At any rate whatever the source of chlorine may be, if it is the aim and object of the process to form chloride of gold, the relative affinities of chlorine for the various metals present is still unaltered. That is to say supposing the chlorine from various sources or in various forms were to have a greater or lesser affinity for gold it would relatively have a greater or lesser affinity for the other baser metals present. Of course if the baser metals are not present in the ore or have been roasted or brought into such a condition that they will not be attacked by chlorine, the above statement still holds good, and chlorine from a chemical source will be just as efficient as chlorine from an electrolytic source. But as Borchers says: "Inventors almost appear to consider that it (the gold) is endowed with life, attributing to it more intelligence than they themselves possess."

As regards the simultaneous deposition of the gold the remarks made further on with reference to gold cyanide apply equally well to gold chloride or bromide.

Another favorite hunting ground for the inventor is in the combination and application of electrolysis with a cyanide solution. Here again much the same lines are followed in all cases, the ore being agitated in a dilute solution of KCN , a current being passed through it which is supposed to assist in the solution of the gold afterwards depositing it at the negative pole either on a sheet of copper, iron, etc., or else into mercury where it forms an amalgam. As an additional advantage it is stated that the mercury having the agitated ore passed over it will amalgamate any coarse gold that may be present, which is no doubt correct. As it is obvious this process must be brought into direct competition with the cyanide process, it must have some additional advantage to justify its existence. That is to say it must be either 1st. Able to treat refractory ores which the cyanide process will not treat, or 2nd. It must give a sufficiently higher extraction to pay for its extra cost of working, if any, or 3rd. It must be cheaper to work. Let us consider the first point. If the process is able to treat ore which the ordinary cyanide process will not, the cyanide must be gifted with some special virtue which it does not possess when used in the ordinary process. We know of course that KCN will dissolve gold, and we also know that if that is made the positive pole in a solution of KCN and a current passed through it, it will dissolve it still more rapidly, but it does not follow that gold in suspension between the poles will be any more attacked than if the current were absent. In fact this is certainly not the case.

It is true that if a sheet of gold is suspended between the + and - poles (but entirely disconnected from them) in a solution of gold salt, it will be dissolved on the side facing the negative but it is equally true that an exactly similar amount will be deposited on the side facing the positive, the total weight of the plate remaining the same. If no gold were deposited none would be dissolved, as polarization would be set up between the two sides and the current would then pass round the plate instead of going through it.

Of course should the gold in the ore touch the positive plate it would tend to go into solution, but owing to its being thoroughly agitated, an essential point of the process, it would not be in contact a sufficient time to be appreciably acted on. The fact that the cyanogen is in a nascent state does not hold as the effect of the current on the weak KCN is not to liberate CN at the anode but O which immediately enters into combination with the KCN to form cyanate KCNO . Getting down to actual facts the writer has never yet been able to detect any advantageous results from the use of the electric current for the purpose of getting gold from an ore into solution. A case came recently under my notice in which the inventor clearly demonstrated to his own satisfaction if not to the writer's, the enormous advantage of using an electric current for getting the gold into solution. It is a matter of detail to add that afterwards it was discovered that some one had forgotten to put the brushes on the dynamo.

Coming now to the second point there are no grounds for believing that a better extraction is obtained for reasons stated above. It is usually regarded by those best qualified to judge that the gold which the cyanide will not touch (except of course in the case of refractory ores) is gold which is "locked up" that is to say that it is imbedded in a piece of gangue so effectually that the solution cannot get at it. There is therefore no reason to expect the electro-cyanide process to touch it any more than the ordinary cyanide process. A small advantage may be gained if the ore is not "locked up" by having a simultaneous amalgamation and cyaniding, the cyanide cleaning the surface of the gold prior to amalgamation. Any great advantage from this source is not, however, borne out by facts.

We now come to the third point. It can be soon shown that the cost of treatment under similar conditions must be higher than the ordinary cyanide process. First: Agitation is not only advisable but essential. Second: There is a larger consumption of cyanide partly due to the oxygen at the positive pole oxidizing it to KCNO and partly due to oxidation by the air to which agitation must necessarily expose it. Third: Loss of mercury (if this is used) due to it getting mixed up in a finely divided state with the ore. It is also claimed that filtration is unnecessary but unless the deposition of the gold from the solution is complete this is not the case, and the solution will have to be recovered and used for the next leaching for the sake of the gold it contains. It is advisable to consider here what is meant by complete, as of course nothing is completely precipitated or deposited from solutions theoretically speaking. The quantity of solution necessary for keeping the ore in the state of a sludge is about one ton of solution per ton of ore, and as this ore frequently only contains a few grams of gold per ton, even if all goes into solution, that solution will contain about an equivalent amount, and if it is to be thrown away without filtration at least 90% must be deposited. So that suppose an ore or tailings contained 5 dwt. per ton, the solution would after agitation contain not more than 5 dwt. per ton also and to deposit out 90% not more than 10 grains must be left in a ton of solution. But even this weak solution is not what would be technically known as completely freed from gold but might be defined as the strongest solution which it would be possible to throw away even when placed under the very best conditions for that purpose.

For those readers who are well versed in electro metallurgy it is unnecessary to say more regarding the difficulty of depositing a metal from a solution even to this degree of completeness, but for the sake of those who are not so well versed a few more words may be added. Suppose we take a strong solution of a salt of any metal, gold for instance, and pass a current of say, 10 amperes per square foot through it, then for every unit of current passed a definite amount of metal is deposited, but if this solution is made weaker and weaker a point is at last reached at which the amount of gold in the solution in contact with the cathode, which is of course the seat of the reaction, is insufficient for that particular current, and part of the current will therefore decompose the water setting free hydrogen. This may be remedied by First: lowering the current and keeping the cathode area the same, or Second: keeping the current the same but increasing the cathode area.

Of course if the output of the plant is to remain constant, which is usually the case, the latter course must be adopted. Then the weaker the solution gets the larger the

cathode area must be until when we get to something like 10 grains per ton of solution, the area will have to be something enormous.

We may have drawn attention, in passing to the Siemens & Halske process where this plan has been adopted. This process does not come strictly under the processes which we have been above considering as it is merely devised with the object of replacing the zinc boxes in the ordinary cyanide process, and has nothing to do directly with the extraction from the ore.

We are now therefore brought to this position, namely that if we require anything like a complete deposition of the gold from solution, we must have an enormously large cathode area. If this cathode is anything of the nature of lead or iron, the gold is worn off from the surface as fast as it is deposited by the agitated ore scouring the surface. If on the other hand mercury is used to absorb the gold and so prevent it being scoured off, a calculation will soon show that the amount of mercury necessary for such large area is so enormous that the process becomes altogether impracticable. Amalgamated plates behave no better than unamalgamated ones and proposals which have been put forward to wash the surface of the plates either continuously or intermittently with mercury are altogether too impracticable to be taken seriously. The only possible alternative now left is to completely recover all the solution and use it over again. But when it is considered that this must be done without increasing the volume of the solution by the addition of washings, the difficulty of doing this will be apparent. If the solution is increased in bulk ever so slightly, at each treatment it will soon mount up after a number of treatments, and as at no stage of the process is the solution sufficiently free from gold to be thrown away, the treatment of this excess has to be considered, and after all is said and done if the current fails to deposit the gold properly where does the advantage of its use come in?

An attempt has been made above to show the difficulties which any one must be prepared to encounter who tackles what looks at first sight like an easy problem, and it is evident that some radical features must be introduced before any successful issue can be arrived at.

A Double Drum Gasoline Hoist.

Gasoline mining hoists for light work have long since ceased to be a novelty. However, they have usually been comparatively small units for a single rope. But for many purposes these hoists have such manifest advantages over steam hoists that it is not surprising that previous limitations have been outgrown.

The Weber Gas & Gasoline Engine Co., of Kansas City, Mo., is building a line of gasoline hoisting engines adapted for any purposes for which steam hoists have been used exclusively in the past.

One of these hoists is shown in the accompanying illustration. It is a double drum reversible hoist, suitable for use in double compartment shafts, double track inclines, or for tail-rope haulings.

The advantages of a double hoisting system in cases where it is possible, have long been familiar to mining engineers. The power required to lift the dead weight of the rope and cage at every trip is dispensed with, and the first cost and cost of operation are thereby greatly reduced. The lowering of the cage by power secures absolute safety, so far as this is possible, and avoids the wear and tear of the machine and rope which occurs when lowering by brake.

The Weber double drum hoists are well arranged to secure all of the advantages of the double drum system, without undue complication. On the hoists shown in the cut the drums are side by side, although in some cases they are arranged in line.

The drums revolve together, the rope being wound opposite on each, so that one drum lowers while the other hoists. When the cages reach the end of the trip, the motion is reversed in a simple but effective manner, although the engine itself runs constantly in one direction. On the engine shaft is mounted a pair of bevel pinions, both of which engage with a single bevel gear mounted on the drum shaft. The pinions are attached to the

engine shaft by means of a pair of friction clutches, and by throwing one or the other in gear, motion is had in either direction. A single lever operates this entire system. On its mid-position neither pinion is in gear, and the drums are stationary. By throwing the lever to one or the other extreme, the drums are made to revolve in a corresponding direction. The lever is moved without exertion on the part of the engineer, and the drums are started, stopped, or reversed in an instant, without jerk to the rope, or shock to the machine.

One of the drums is connected to the drum shaft by means of a friction clutch, so that one rope may be paid out independently of the other. This clutch is used when it becomes necessary to change the level reached by the lower cage when the upper cage is at the surface. Two brakes are provided, one for each drum, for use while this is being done.

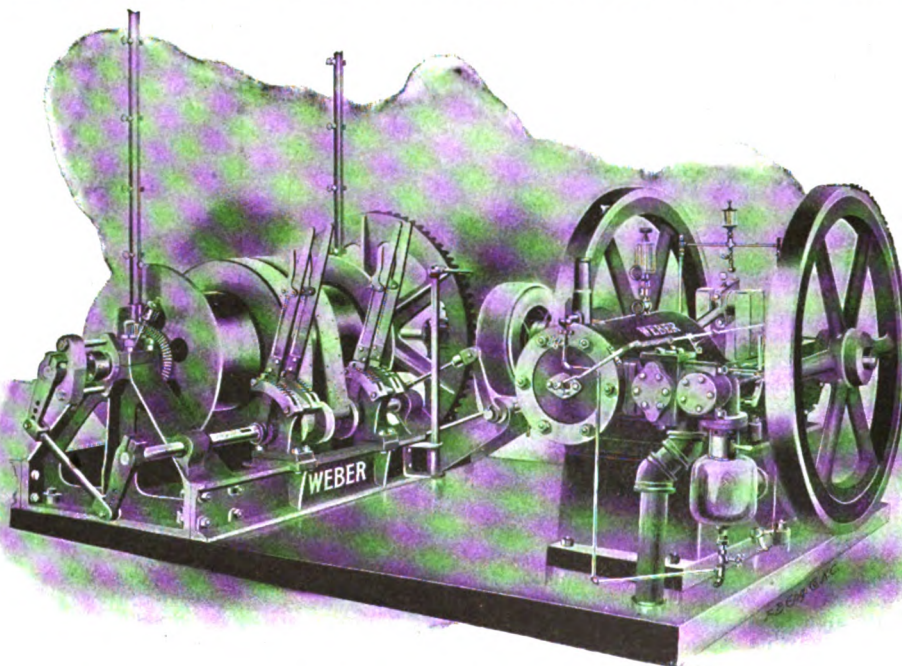
The friction clutch and the two brakes also enable either drum to be used independently of the other, if desired, giving an extremely flexible arrangement.

The friction clutches are very compact, and yet powerful enough to transmit the full power of the engine without undue strain. The whole arrangement of clutches and bevel gears is very ingenious and secures all the desired results with a minimum of complication, and without loss of power.

The brakes are powerful enough to hold the entire load on either drum, and have surface enough to control the lowering without undue heating. Of course the brakes are not used for this purpose in the normal operation of the hoist, but may be upon occasion. All of the operating levers are assembled in one convenient place. One lever controls the speed of the engine, and by simply moving it, the speed may be varied at will from the least speed that enables the engine to turn over, to the greatest speed desirable. All parts of the engine and hoist are built in accordance with the most approved practice, and altogether the machine will be found thoroughly satisfactory.

Ohio Institute of Mining Engineers.

At the annual meeting of the Ohio Institute of Mining Engineers held in Columbus, Ohio, on Feb'y 26, 27, and 28, the following papers were scheduled to be read: Prof. N. W. Lord, The Economic Value of the Clarion Coal; J. W. Jones, Gallipolis, Ohio, Portland Cement in Southern Ohio; R. M. Haseltine, The



Lignite Coals of North Dakota; Hon. Anthony Howells, Massillon, Ohio, Coal and Coal Mining in South Wales; Robert B. Collier, Columbus, Ohio, Notes on Costa Rica, Central America; Prof. F. C. Caldwell, Columbus, Ohio, Long Distance Electrical Power-Transmission from Coal Mines; Prof. Edw. Orton, Jr., State Geologist, Columbus, Ohio, The Cement Materials of Ohio, and a Method for their Chemical Examination. J. T. Phillips, St. Charles, Michigan, Coal Mining in Michigan; David C. Thomas, Glouster, Ohio, Mine Discipline; Solon C. Smith, Jackson, Ohio, Sewerage and Sewerage Disposal; Prof. N. W. Lord, illustrated lecture, The Metallurgy of Copper in Montana.

WIRE ROPES.

A Reference to Some Important Facts Shown by Experiments
Described in a Paper by Mr. Andrew S. Biggart.*

Written for MINES AND MINERALS by J. T. Beard, C. E., E. M.

The overloading of wire ropes used for hoisting or haulage purposes is one of the most common occurrences in mining practice. The ever increasing demands upon all classes of mining machinery make this result almost inevitable. The users of wire ropes in mining practice are in many cases well acquainted with the extraordinary loads thrust upon the rope where the latter is bent around a sheave of too small a diameter. The

sheave may be employed as a guide sheave to deflect the rope through a slight angle only, or as in a tail sheave the rope may make a full half-turn around the sheave. In the former case when the angle of bending is small, the ill effects resulting from the bending are likewise small. Also, the diminishing of the load upon the rope reduces the ill effects of bending. It will not surprise those who have given the subject any careful consideration, when it is said that the extra load thrown upon the rope, by causing it to bend over a sheave of medium diameter, may be, and often is, many times in excess of the net or working load. For example, it is nothing uncommon for a wire rope carrying a net load of, say 10 tons to be subjected to an extra load of three or four times this amount by bending over deflecting or hoisting sheaves. At the same time these sheaves may be of such a

TABLE 1.

Maker.	Circumference.	Quality of Steel.	Weight per Fathom.	Strands.						Breaking Weight of Rope, Average of Two.	Breaking Weight of Wire, Average of Six.	Breaking Weight of Wires, per Square Inch.	No. of Wires Multiplied by Their Average Breaking Weight.	Loss per Cent.	Ductile Test.	Remarks.
				Number of Strands.	Number of Wires in One Strand.	Total Number of Wires.	Diameter and Area of Wires.									
							Diameter.	B. W. G.	Area.							
	In.		Lb.				In.		Sq. In.	Tons. (2,240 Lb.)	Lb.	Tons. (2,240 Lb.)	Tons. (2,240 Lb.)			
T. & W. Smith	1½	Crucible	2.05	6	12	72	0.086	20	0.0010	6.80	212	91.64	6.82	0.8	78	Ordinary flexible.
T. & W. Smith	1½	Crucible	2.55	6	24	144	0.086	20	0.0010	10.47	190	84.32	12.22	14.3	78	Special flexible.
T. & W. Smith	1½	Crucible	2.10	6	12	72	0.086	20	0.0010	6.82	230	102.68	7.39	10.8	92	Ungalvanized.
Bullivant & Co.	1½	Crucible	2.00	6	12	72	0.040	19	0.0013	5.85	200	87.68	6.43	9.0	66	Oiled in manufacture.
Dixon, Corbett & Newall	1½	Crucible	.....	6	12	72	0.040	19	0.0013	9.85	228	78.29	.....	.....	46	Lang's patent lay.
R. S. Newall	1½	Crucible	.....	6	19	114	0.086	20	0.0010	5.75	210	98.75	.....	.....	83	Ungalvanized.
T. & W. Smith	2½	Crucible	4.55	6	24	144	0.040	19	0.0013	14.85	263	90.80	16.91	12.2	80	Ordinary flexible.
T. & W. Smith	2½	Crucible	6.86	6	24	144	0.048	18	0.0018	21.90	367	91.10	23.69	7.2	.....	Ordinary flexible.
T. & W. Smith	3	Bessemer	.....	6	7	42	0.110	11½	0.0096	14.10	1,123	52.77	21.05	83.0	.....	.....
T. & W. Smith	4	Bessemer	.....	6	7	42	0.144	9	0.0163	26.10	1,698	46.36	81.74	17.8	.....	.....

TABLE 3.—TESTS OF TWO SINGLE WIRES, ONE GALVANIZED AND ONE NOT GALVANIZED, BOTH BEFORE AND AFTER BEING ANNEALED.

Not Annealed.							Annealed.						
No.	Galvanized.			Ungalvanized.			No.	Galvanized.			Ungalvanized.		
	No. of Turns. (30 Lb. Tension.)	No. of Turns. (No Tension.)	Breaking Weight. (Lb.)	No. of Turns. (30 Lb. Tension.)	No. of Turns. (No Tension.)	Breaking Weight. (Lb.)		No. of Turns. (30 Lb. Tension.)	No. of Turns. (No Tension.)	Breaking Weight. (Lb.)	No. of Turns. (30 Lb. Tension.)	No. of Turns. (No Tension.)	Breaking Weight. (Lb.)
			Lb.			Lb.				Lb.			Lb.
1	82	79	205	101	101	207	1	66	57	118	161	168	123
2	93	86	209	95	96	225	2	68	72	121	157	153	115
3	82	81	208	99	110	219	3	52	84	119	176	184	118
4	86	91	205	102	95	220	4	61	33	119	178	192	121
5	76	89	207	104	102	225	5	77	57	118	183	180	122
6	93	85	209	98	100	220	6	36	42	118	129	190	120
Average of 12 Tests	85	86	207	101	102	217	Average of 12 Tests.	59	56	118	174	183	120
Average 85.5			101.5			57.5			178.5				

TABLE 4.—VARIATION IN DUCTILITY OF ADJACENT LENGTHS OF SIX WIRES, TAKEN FROM GALVANIZED ROPE 1½-INCHES IN CIRCUMFERENCE.

The length of the part of the wire subjected to twisting was in all cases 3 inches, and the wires were tested alternately, with and without a tension of 30 pounds upon the wire.

Description.	Lengths.	First Wire.		Second Wire.		Third Wire.		Fourth Wire.		Fifth Wire.		Sixth Wire.	
		No. of Turns (30 Lb. Tension.)		No. of Turns (No Tension.)		No. of Turns (30 Lb. Tension.)		No. of Turns (No Tension.)		No. of Turns (30 Lb. Tension.)		No. of Turns (No Tension.)	
		No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)	No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)	No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)	No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)	No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)	No. of Turns (30 Lb. Tension.)	No. of Turns (No Tension.)
Wires taken from Messrs. T. & W. Smith's ordinary flexible 1½-inch rope, galvanized wire, 20 B. W. G.	1	50	35	60	66	86	86	62	59	84	76	86	76
	2	31	50	55	66	78	96	72	65	80	70	77	88
	3	37	53	58	70	70	70	70	80	80	80	80	80

Average with tension = 67.

Average without tension = 69.

TABLE 5.

Showing the limit and modulus of elasticity of (1) galvanized crucible steel wire, 20 B. W. G. (0.001 inch diameter); (2) iron wire, 19 B. W. G. (0.0018 inch diameter); both supplied by Messrs. T. & W. Smith, as being similar to those used in their ordinary 1½-inch ropes; (3) piano wire, 22 B. W. G. (0.028 inch diameter); each the average of two tests. Length of wire experimented on in each case = 100 inches.

Tension.	(1.) Crucible Steel.		(2.) Iron Wire (Bessemer).		(3.) Piano Wire (Ungalvanized).	
	Extension.	Permanent Set.	Extension.	Permanent Set	Extension.	Permanent Set.
Lb.	In.	In.	In.	In.	In.	In.
10	0.03		0.025		0.025	
20	0.06		0.060		0.075	
30	0.09		0.100		0.125	
				{ Modulus of elasticity, 22,400,000 lb. }		
				Permanent set commences at 14 long tons per sq. in.		
40	0.12		0.130	0.01	0.150	
50	0.15		0.175	0.02	0.200	
60	0.18		0.220	0.035	0.275	
70	0.21		0.260	0.05	0.325	
80	0.24		0.310	0.075	0.375	
90	0.28		0.360	0.10	0.425	
100	0.32		0.420	0.125	0.500	
						Modulus of elasticity, 35,000,000 lb.
						Permanent set commences at 47 long tons per sq. in.
110	0.36		0.500	0.15	0.525	0.005
		Permanent set commences at 50 long tons per sq. in.				
120	0.39	0.05	0.600	0.20	0.580	0.01
130	0.43	0.01	0.800	0.36	0.640	0.02
			{ 134 lb. = 60 long tons per sq. in. }	Broke.		
140	0.46	0.02			0.720	0.03
150	0.51	0.03			0.770	0.04
160	0.55	0.04			0.850	0.07
170	0.59	0.06			0.900	0.08
180	0.64	0.08			1.000	0.12
190	0.74	0.30			1.120	0.16
200	1.40	0.42			1.200	0.20
210	2.50	1.75			1.350	0.30
						0.42
228 lb. = 102 long tons per sq. in. }	5.50	Broke.			220 lb. = 1.6'' 225 lb. = 1.75'' 230 lb. = 103 long tons per sq. in. }	Broke.

but the wires fit each other snugly so as to form a smooth surface for each layer. In this form the cutting action of the wires is reduced to a minimum. There is indeed practically no cutting of the wires in this rope.

Failure of ropes is attributable more or less to three causes. (1) Fatigue in the wire, (2) Internal cutting or mutual abrasion of the wires of the rope, (3) External wearing or abrasion incident to use. The first of these contributory causes is slight in its effect upon the life of the rope. Comparatively few haulage or hoisting ropes fail owing to fatigue in the wire. The second cause mentioned above is responsible for the large majority of the failures of ropes, both of the ordinary laid rope as well as of the Lang-lay rope. A large majority of the ropes employed at the present time in mining operations, both for hoisting and for haulage purposes are of the hawser laid type first mentioned above. It would probably be no exaggeration to say that in the use of these ropes 75 per cent. of the causes of ultimate failure are internal cutting and abrasion of the wires. In perhaps 25 per cent. of the cases the life of the rope has been maintained until finally terminated by external wear or abrasion.

The foregoing remarks have been brought out by the perusal of a deeply interesting paper recently sent us by Mr. W. D. L. Hardie, superintendent for the Alberta Railway and Coal Company, Lethbridge, Canada. This paper, entitled "Wire Ropes," was written by Andrew Stevenson Biggart, and was read before the Institute of Civil Engineers, of Great Britain, at its association meeting 1889-90. The

diameter as would seem sufficient to one who had never carefully investigated the subject.

The style of rope employed has an important bearing upon the length of time a rope can be maintained in service, or as we say, upon the life of the rope. There are three principal features, in rope manufacture, which affect directly and largely the life of the rope. These features are exemplified in (1) The ordinary hawser or shroud laid ropes, (2) The Lang-lay rope, (3) The Locked wire rope. In the first of these three types the wires forming the strands are usually laid up from left to right, while the strands forming the rope are laid up from right to left. This causes the wires of one strand to cross the wires of other strands at a sharp cutting angle, the result being that in this form of rope the cutting action of the wires upon each other is greatest. In the second or Lang-lay method of rope manufacture the wires forming the strands and the strands forming the rope are all laid up in the same direction usually from right to left. The result of this is that the wires of one strand lay into the wires of all the other strands instead of crossing them, and the cutting action of the wires is very largely reduced. In the third form or Locked wire rope, the wires are arranged in successive layers about a central core, the lay or twist being in opposite directions in each layer,

paper describes a series of tests performed upon wire ropes to ascertain the relative performances of these ropes under the varying conditions to which they are subjected in practice. These tests consisted in causing the different ropes to travel under varying loads while passing over sheaves of different

TABLE 6.—THE LIFE OF FLEXIBLE STEEL WIRE ROPES WHEN RUNNING OVER IRON PULLEYS. The figures in the table give the number of times the rope passed over the various pulleys before breaking. All ropes 1½ inches in circumference. Load on rope 1,400 pounds

Description of Rope.	Diameter of Pulleys in Inches.						
	5½	7½	10½	13½	16½	18½	24
T. & W. Smith's ordinary rope	6,075	10,300	16,000	23,400	46,800	72,700	74,100
Bullivant & Co.'s			34,800			100,200	836,600
Lang's patent lay			53,100	85,200		392,500	
T. & W. Smith's ordinary rope, oiled			34,700	87,300		163,200	386,100
Lang's patent lay, oiled			107,600	142,700			

TABLE 7.—LIFE OF ROPES WHEN RUNNING OVER 24-INCH DIAMETER PULLEYS. LOAD 1,400 POUNDS.

Description of Rope.	Total Number of Bends Before the Rope Breaks When	
	Running Over One 24-Inch Pulley. (Fig. 1.)	Running Over Three 24-Inch Pulleys. (Fig. 2.)
No. 0. Smith's ordinary crucible steel, wire and strands laid in opposite directions	74,100	51,000
No. 1. Smith's rope, wire and strands laid in the same direction		126,000
No. 2. Smith's patent improved steel, wire and strands laid in opposite directions	96,000	57,000
No. 3. Smith's plough steel, wire and strands laid in opposite directions	109,000	54,000
No. 4. Smith's iron wire, 19 B. W. G., wire and strands laid in opposite directions	66,000	32,000
No. 5. Smith's crucible steel, 18 B. W. G., wire and strands laid in opposite directions	87,000	47,400
No. 6. Smith's crucible steel, 22 B. W. G., wire and strands laid in opposite directions	111,000	48,700

With the exception of Nos. 4, 5, and 6, the wires composing all ropes were 20 B. W. G.

diameters. The experiments were conducted both with respect to direct and reverse stresses; by reverse stresses being meant loads due to bending over sheaves, in contrary directions. The number of times a rope was passed over a pulley or the number of bendings of the rope was carefully noted up to the time of the parting of the first wire, and then up to the final rupture of the rope. The load upon the rope in every case was a uniform load of 1,400 pounds. Another test of the wires forming the ropes was made before and after the breaking of the rope to determine the ductility of the wire. This test was expected to serve as a gauge of the effects produced upon the rope by bending. This test was a so called torsion test, in which the wire

the lowest being .3 per cent. while the highest percentage of loss is 33 per cent.

Table 3 shows the results of the tension test applied to crucible steel wires, No. 20, B. W. G., furnished by Messrs T. and W. Smith, and used by them in the manufacture of 1½-inch rope. The test was applied alternately with and without initial tension, that is to say, after the wire was gripped by the machine a tension of 30 pounds was given to the wire before twisting, or the wire was twisted in the second case without any previous tension. These wires were galvanized and ungalvanized, and annealed and unannealed. The effect of using galvanized wires seems to be to greatly reduce the ductility of the wire, and this loss of ductility

TABLE 8.—LIFE OF SINGLE WIRES TAKEN FROM ROPES NOS. 2 TO 6, RUNNING OVER PULLEYS OF 5½, 10½, AND 24 INCHES DIAMETER, AND LOADED IN EACH CASE WITH ONE-TENTH OF THEIR BREAKING WEIGHT.

Description.	Number of Bends Before Breaking.			Calculated Stresses.		
	Average of Two Tests. (Fig. 1.)			Diameter of Pulley. (Inches.)	Stress From Bending. (Tons per Sq. In.)	Stress From Direct Tension. (Tons per Sq. In.)
	5½-Inch Pulley.	10½-Inch Pulley.	24-Inch Pulley.			
No. 2. Improved steel; wires 20 B. W. G.	15,200	104,000	458,000	{ 5½ 10½ 24	100 50 22	8.3 8.8 8.3
No. 3. Plough steel; wires 20 B. W. G.	22,000	128,700	181,300	{ 5½ 10½ 24	100 50 22	12.0 12.0 12.0
No. 4. Iron wire; wires 19 B. W. G.	12,800	83,500	355,800	{ 5½ 10½ 24	76 38 17	4.5 4.5 4.5
No. 5. Crucible steel; wires 18 B. W. G.		45,000	123,400	{ 5½ 10½ 24	184 67 29	8.6 8.6 8.6
No. 6. Crucible steel; wires 22 B. W. G.	20,000		282,000	{ 5½ 10½ 24	78 39 17	9.2 9.2 9.2

In the above table the following values for E have been taken: for steel wire, 14,700 long tons; for iron wire, 10,000 long tons.

of a certain length (8 in.) was gripped strongly by a testing machine and turned or twisted by rotating one end until broken, the number of complete turns being carefully noted in each case.

Fig. 1 is a sketch showing the outline of the machine used for bending the ropes over the pulleys. Owing to the difficulty of making a splice of sufficient strength in the short length of rope employed, splicing was abandoned and the rope to be tested was coupled by eyes or shackles attached to the ends of the rope a , Fig. 1. A reciprocating motion was given to the rope passing over the sheaves by causing the latter to alternate in the direction of their revolution, at regular intervals. AB represents a horizontal lever carrying the weight W , which was adjusted

in galvanized wires is greater in the annealed than in the unannealed wires. There is also a loss of tensional strength in the annealed wires as compared with the unannealed. These wires were all made from crucible steel, and sustain an average tensional strength of from 80 to 90 pounds per square inch.

Table 4 shows the results obtained by applying the torsion test both with and without tension to wires taken from each of the 6 strands of T. W. Smith's flexible 1½-inch rope, galvanized wire, 20 B. W. G. Each wire before testing was cut into five or six separate lengths, the test with and without tension being applied alternately to these lengths.

A similar test made with wires taken from Messrs. Bullivant

TABLE 9.—TEST OF SINGLE WIRES AFTER RUNNING OVER PULLEYS 10½ INCHES IN DIAMETER, AND LOADED IN EACH CASE WITH ONE-TENTH OF THE BREAKING WEIGHT OF THE WIRE.

Description of Wire.	Number of Bends Over Pulley.	Tensional Strength. (Tons per Sq. In.)		Percentage of ultimate Elongation. (Average of Two Tests.)		Torsional Test. (Average of 36 Tests.)	
		Before Running.	After Running.	Before Running.	After Running.	Before Running.	After Running.
No. 1, Smith's crucible steel, 20 B. W. G.	5,000	100				71	77
	10,000	100	100	5.5	3.4	71	56
	15,000	100	98	5.5	3.0	71	32
No. 2, Improved steel (crucible), 20 B. W. G.	30,000	83	76	1.0	1.2	108	103
	60,000	83				108	69
	90,000	83				108	18
No. 3, Iron wire (Bessemer), 20 B. W. G.	15,000	45	45	0.75	1.75	69	29
	30,000	45	45	0.75	1.25	69	31
	45,000	45	42	0.75	0.75	69	18

during each test so as to throw a load of 1,400 pounds upon the rope. In Fig. 1 the pulleys are shown as they were employed in determining the effect of bending when all the stresses were direct, that is to say, when the bending of the rope was all in one direction. Fig. 2 shows the arrangement of the pulleys employed to determine the effect of reversed stress due to bending the rope in opposite directions.

We give herewith the most essential portions of Mr. Biggart's tables illustrating these experiments. An interesting fact shown in Table 1 is the loss per cent. of strength when the wires are laid up into a rope as compared with their aggregate strength when tested separately. This loss of strength shows a large variation,

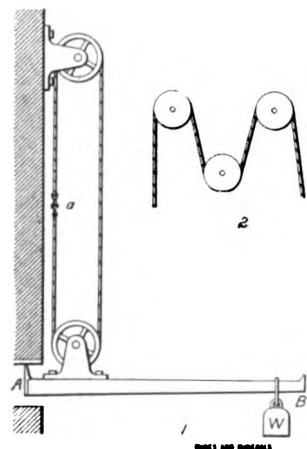
& Co.'s flexible 1½-inch rope, galvanized wire, 20 B. W. G. gave an average of 62 turns with and without tension.

Similar tests made with wires taken from Messrs. T. & W. Smith's 1½-inch rope, ungalvanized wire, 20 B. W. G., gave an average of 92 turns, both with and without tension.

The wires in the first two ropes were galvanized, while those in the last rope were ungalvanized, which accounts for the average results in the last case being so much greater than in the other two cases. It is observable that while there is some variation shown by the several lengths, the average results in each case show little difference, whether the test was applied with or without previous tension, these average results being quite uniform.

Table 5 shows the results of applying tension to three different kinds of wire. As will be observed from the table the modulus of elasticity is calculated from the average values of the extension within the limits of elasticity. The modulus of elasticity is the ratio that the unit stress or stress per unit of area, bears to the unit extension or the extension per unit of length. The point at which permanent set or deformity takes place is noted in each case in long tons per square inch; and the amount of permanent set is given in inches for each tension or strain thereafter.

Tables 6 and 7 show the results of bending different ropes over different sized pulleys, under a fixed load (1,400 lb.). Table 8 shows the effect of bending single wires over pulleys of different diameters, the wire in each case being loaded with $\frac{1}{10}$ of its breaking weight. In this table is given, in addition to the number of bends made by the rope before breaking, the stress upon the rope due to bending as well as the stress (tons per sq. in.) due to direct tension. The stress due to bending is a unit stress (tons per sq. in.) and is calculated from the usual formula $f = E \frac{d}{R}$. Mr. Biggart in his paper states that "If the wire is bent to a radius R the bending moment at any point is $M = \frac{EI}{R}$, where I is the moment of inertia of the section of the wire, and E the modulus of elasticity. The stress consequently due to bending is $f = \frac{EI}{2R}$ ". This is seemingly a typographical error substituting I for d , and Mr. Biggart's own results obtained in Table 8 indicate this, since they conform to the formula first above given. We do not understand why he should refer to the bending moment at all, since the unit stress is calculated for the ultimate fiber of the rope or wire, or the outermost fiber when the rope or wire is bent over a sheave. The expression for this unit stress upon the ultimate fiber due to flexure or bending is derived very simply, as follows. Suppose (Fig. 3) AB to be the neutral axis of a longitudinal section of any material subjected to bending, indicate the radius of the neutral axis by R and let r equal the radius of the cross-section or the distance of the outer fiber from the neutral axis. Assuming, as we may, that the material is homogeneous and the neutral axis central in the figure, the lengths of the relative arcs assumed by the neutral axis, the outer fiber ab , and the inner fiber cd , are, respectively, R , $R+r$, and $R-r$. This is true since the arcs are proportional to their respective radii. The length R of the neutral axis is the original length of all the fibers of the material, and hence the extension of the outer fiber due to bending is $(R+r) - R = r$. In the same manner the compression of the inner fiber is $R - (R-r) = r$; the extension of the outer fiber and the compression of the inner fiber being equal since the coefficients of elasticity for extension and compression are practically equal. The extension of the outer fiber per unit of length is then $\frac{r}{R}$. Now, from the definition of the modulus of elasticity (The modulus of elasticity (E) is the ratio of the unit stress (f) to the unit extension ($\frac{r}{R}$)). We write $E = \frac{f}{\frac{r}{R}}$, from which we obtain $f = E \frac{r}{R}$, or writing the ratio of the diameters $\frac{d}{D}$ instead of the ratio of the radii $\frac{r}{R}$, we have $f = E \frac{d}{D}$, which is the usual formula for determining the unit stress in the outermost fiber due to bending.



FIGS. 1 AND 2.

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Table 9 is an interesting table showing the results of the tension and torsion tests applied to three wires, each of three different kinds of steel, after being run over a 10½-inch pulley, and subjected to the specified number of bends. The table shows the results of the tests applied before and after running.

Mr. Biggart's paper cannot fail to be of interest to all users of wire ropes. It embodies many important points brought out in a careful study of ropes, which will be of great interest to manufacturers. Considerable emphasis is rightly laid upon the cutting effect upon each other of the different wires forming the rope, particularly when the latter is bent more or less sharply over a pulley or sheave while carrying a given load. This effect is reduced very rapidly as the diameter of the sheave is increased, or as the angle of bending or deflection of the rope is less, and as the rope carries a lighter load. The maximum injury to the rope is obtained when running a heavily loaded rope over a sheave of too small a diameter. The load due to bending under these circumstances exceeds many times the actual working load upon the rope.

Another important point is the advantage gained by proper lubrication, both in the use of ropes as well as in their manufacture. This lubrication properly and regularly applied to any rope in constant use, will greatly increase the life of the rope as the mutual cutting of the wires is greatly reduced thereby. Attention is also drawn by this paper to the fact that ropes should not be subjected to reversed strains at two points not far apart. This should be avoided whenever it is practicable to do so. The fact is also quite well developed and proven that the lay of the rope has an important bearing upon the life of the same, the reason for this being wholly attributed to the cutting action which the several wires forming the rope exert on each other. The influence of the Lang-lay and the use of oil in the manufacture of ropes is plainly shown. It appears from a careful study of the tables as given in this paper that the use of plough steel, in rope manufacture, is practically limited. This is an important feature which the tests applied by Mr. Biggart have clearly developed. It appears from the tables that while plough steel and piano wires give high results in the tension test, the values of these wires in the torsion test are uniformly low. Beyond certain limits also the bending test of plough steel ropes is low. For example, in Table 8, plough steel rope No. 3 while showing high results when strained over 5½" or 10½" pulleys does not show the remarkably high results obtained by the other ropes when the 24-inch pulley is used. In other words, the plough steel rope possesses a high resistance to tension, and is adapted to use when small pulleys are a necessity; but there is not the same large advantage arising from the use of large pulleys that there is with other ropes.

The results of these experiments show quite conclusively that certain forms of improved steel wire, or even iron wire are to be preferred in certain haulage where the load is sufficiently light so that too large a rope will not be required, and where the rope is subjected to much bending, being conducted by devious ways over numerous sheaves and where reversed stresses are liable to occur. The caution must be observed, however, that the life of an iron wire rope would be much reduced where there is a large amount of external abrasion, since these ropes do not wear as well as the harder steel ropes, and the latter should only give place to the former when the load to be carried is light and the rope subjected to much bending and the conditions are such as not to produce excessive wear. In general the steel rope will give longer life when traveling over small sheaves than an iron rope designed for the same work. The sheaves required in the use of the iron rope must necessarily be larger.

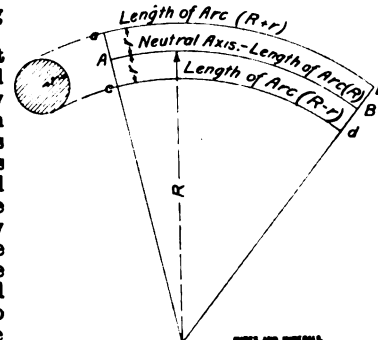


FIG. 3.

Temperatures of Rocks.

The temperature of the rock strata in the Ruhr coal-field of Germany forms the subject of a communication, illustrated by diagrams, to *Glückauf* of September 1 by Bergassessor Kette, of the Karsten Centrum Colliery, Upper Silesia, who arrives at the following conclusions: The collective result of the measurements is that, on an average and under normal conditions, an increase in the rock temperature of 1° Cent. (1.8° F.) for every 92 ft. of depth can be reckoned upon in the collieries of the Ruhr basin; but as regards those mines in which the coal must be got under a very thick cover, a rather more rapid increase of temperature may be expected, which will probably attain the value given by von Huyssen of 1 deg. Cent. for every 82 ft. increase of depth. Variations from 25 to 30 metres for 1 deg. Cent. have hitherto only been observed by way of exception, and to some extent depend upon special conditions existing at the point where the measurement is taken—the influence of hot springs, for instance.

A NEW COAL FIELD

In Northwestern New Mexico—An Exploring Expedition in a Comparatively Unknown Region.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

We stepped from the car of the Santa Fe Railroad onto the platform of a little lone station in New Mexico. The sun was just rising over the distant mesas and table lands of yellow sandstone and dark lava. Sandstone bluffs and lava-capped tables were all around us. On top of one of these was a village of square adobe buildings, the houses rising in terraces, one above the other, forming a castle-like outline silhouetted against the morning sky. On the flat tops of the yellow houses figures wrapped in gay blankets paced up and down or stood motionless like sentinels. Indian maidens were coming down from the village to a well in the station grounds with gay colored shawls thrown over their heads, their ankles clothed in neat white buckskin leggings and their feet covered by moccasins. Each carried a large vessel of native pottery poised on the head. We only needed a camel to complete the intensely oriental character of the scene.

This was the village of Laguna of the Pueblo Indians surrounded by its orchards of plum, pear, and apple trees.

After a breakfast on "Chili con carne" (native peppers and meat) and native bread and "tortillas" (large pancakes of corn meal) we started with a surveyor, and a taciturn, but willing Indian boy as a driver in a wagon drawn by a mule and a horse over the desert west of the Santa Fe Railway.

The geological formations along the road were of the Jurassic period consisting of the massive cross-bedded yellow sandstones which lie at the base of the Jurassic series. These were nearly horizontal and were sculptured by erosion into caves and fantastic monuments. On a platform of these rocks the Pueblo village of Laguna is picturesquely located. Below this platform

dikes of basalt filling the joint cracks between the strata, and sometimes connected above, with a basaltic overflow cap.

The plateau was succeeded by a more open country underlain by the shales of the Marine Cretaceous capped by the yellow sandstones of the Foxhills group of the Cretaceous. A massive sandstone of this group, pitted with peculiar markings of an ancient seaweed and from this cause named by geologists the "Fucoidal" sandstone, is recognized in the West by all coal prospectors as the bed rock or basal rock of coal and of the coal-bearing Laramie series.

On a prominent table of this rock the picturesque little village of the Pueblo Indians, called Paguate, is located. Its houses like Laguna rise in terraces surmounted by one prominent square building, like an ancient fort or castle. The village was neat and clean, some of the houses being whitewashed, both inside and out. We dined in one of these and were waited on by a little Pueblo lady dressed in the tasteful handsome manner of the tribe.

These are a good natured, thrifty and industrious class of Indians. There is a government school in their midst, and the children are apt and docile learners.

The fossil seaweed marks were very apparent in the village street. This street is formed by the pathway of an eroded basaltic dike which passes through the village and traverses the distant hills for miles with a course as straight as one laid down by a compass.

The village with its surroundings of sculptured table lands, sharp volcanic peaks, its neat yellow houses sometimes thatched by heaps of Indian corn stalks, the walls adorned by garlands of bright scarlet Indian peppers, the gay and picturesque dresses of the natives, all these bathed in the hues of the sunset, were a picture for an artist. The distant scene was equally picturesque, plateau rising upon plateau, with here and there a prominent tower or sharp peak of dark lava, marking either the site of an ancient volcano, or the passage of a great dike of lava through a fissure extending for miles across the country.



THE COAL PLATEAU.

he river has cut deeply through about 100 feet of adobe soil of late Quaternary age. The banks of the stream are capped by a somewhat recent looking flow of basaltic lava. Near the bottom of this adobe bank a cave-in sometime since revealed an ancient stone house. The thickness of the river deposit overlying this building indicates the great age at which this portion of the country was inhabited. Fragments of ancient pottery cover the hills. The few resident Americans of this region are naturally archeologists and ethnologists and are all collectors of Indian relics. One of them, a Mr. Gunn, is at present engaged in collecting and publishing the folk-lore stories of the Pueblo and Navajo Indian tribes.

My companion, Colonel P., gave me throughout the trip a vast amount of information of the early history of these interesting Indian tribes. It is into such regions that the Smithsonian sends its ethnologist collectors, such as the late Lieutenant Cushman, Messrs. Cushman, Hodge and others.

Our course lay to the northwest over a region little visited except by the Mexican and Navajo Indians. No geologist, so far as I could learn, had been over there. The region was not attractive to prospectors either.

The plateaus are overlain by, in some cases, very recent looking flows of basalt, traceable to still existing craters. One flow following an arroyo close to the Santa Fe Railroad track in ropy coils and rugged cinders is so fresh that vegetation has scarcely yet invaded it. The Indians still retain traditions of great earthquakes and eruptions of molten rock, fire, and smoke. Some of these lava flows are of Quaternary or post Quaternary date; others are earlier and probably of Tertiary age.

As we progressed northward the sterile plain, scantily clothed with cactus, was succeeded by a tall plateau underlain by the variegated pink, green, and gray marls of the Upper Jurassic, capped by the heavy sandstones of the Dakota group of the Lower Cretaceous. This plateau was penetrated by numerous small

The country is eminently volcanic and to the westward is the prominent volcanic cone of Mt. Taylor.

Bidding farewell to our hospitable Pueblo friends, our course continued northward in the direction of another great mesa, at the base of which at the outlet of a canyon, is the Mexican village of Ceboyeta.

This mesa, as we had anticipated from our discovery of the basal fucoidal sandstone in the plain below, was formed above of the coal-bearing series of the Laramie Cretaceous.

We were not surprised, therefore, to find in it a workable coal seam, about half way up its slope, between beds of horizontal sandstone capped at the summit by a thick and wide flow of basalt. We had thus accomplished one point in our expedition, which was to ascertain if coal, or coal-bearing strata, existed at all in this region. We may observe here the use of geology in giving us our horizon at Laguna of Jurassic rocks, upon which we knew further on we must find successively the lower Cretaceous, then the "basal" sandstone, and finally the coal-bearing Laramie group of the West, and strong probabilities of the existence of coal in it, provided the strata were not removed by erosion.

The Mexican village of Ceboyeta was naturally fortified by the castles of sandstone and volcanic peaks surrounding it. These were the watch towers upon which formerly sentinels were posted to give warning of the approach of the constantly raiding Apaches. These would at harvest time descend upon the village, and while the "braves" stormed the walls and fought the Mexicans from house to house, the Apache women and children gathered the crop, washed, thrashed, sacked, and packed it on their horses.

The valley has been the scene in past time of Indian raids from the old Spanish days up to the time of the arrival of General Canby and the American troops. There are old mud round-tower forts in the village and loopholed buildings; pieces of chain armor of the Spanish dragoons have been found, together with

The country now showed signs of great past erosion and was cut up by canyons, and eroded into forms resembling in miniature those depicted by Powell and others in the Grand Canyon

"To determine the character of an untried seam a number of sections are necessary from widely separated points in order to show such variations as exist. A reasonable amount of development under cover would appear to be necessary in order to determine what changes obtain in the outcrop of each seam."

IDEAL SECTION OF COUNTRY SHOWING STRUCTURE FROM LAGUNA TO CHAVEZ MESA.

We had been in hopes of finding coal at contact with some of the great volcanic intrusions, with a possibility of the heat metamorphosing it into anthracite or into a coking quality, but

VOLCANIC NECKS AND DIKES NEAR VILLAGE OF JUANTEFOYA, NEW MEX.

at intervals remaining, coal field stretching from the Santa Fe Railroad and Gallup mines in the south, to the La Plata coal field on the north, developed by the mines of Durango in the south-western confines of Colorado. Our explorations proved what perhaps many people had not supposed, viz.: that there is a vast coal field in this northwestern part of New Mexico, and that all the available coal is by no means confined to Gallup on the Santa Fe road, where only it is at present mined.

We beg to state that this Company has no connection whatever with the Edison-Holzer Steel & Iron Process Company, nor do we in any way endorse the merits claimed by them for their process for treating steel." E. M. McILVAIN, Vice-President.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Mine Managers' Examination, Held at Springfield, Illinois, December 10, 1900.

QUES. 1.—What is meant in Geology by the "Carboniferous measures," and of what materials are these measures principally composed?

ANS.—The term Carboniferous measures, as used in Geology, refers to all those strata deposited during the Carboniferous age. In a more restricted sense, the term is applied to those strata only that belong to the Carboniferous period, and lying between the Sub-Carboniferous and the Permian periods. These strata contain all the most important coal measures, embracing the coal formations of the Appalachian Region and the Central Basin. Beside the coal seams, the principal materials composing these strata are, in the Appalachian Region, conglomerates, shales, fireclay and sandstones, while in the Central Basin limestones and shales predominate. In connection with each coal seam, there is frequently a stratum of fireclay of varying thickness.

QUES. 2.—What are the structural differences between "slate" and "clod"?

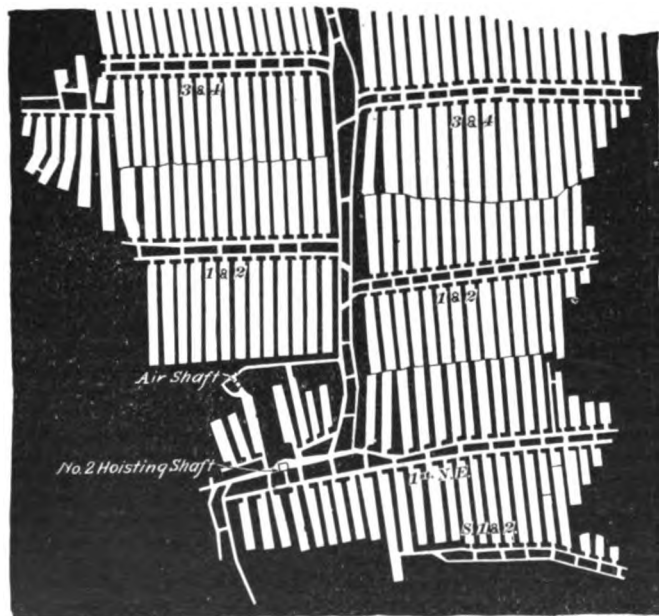
ANS.—Each of these is a clay formation. Slate is generally harder and purer than clod, and has a well defined cleavage in the plane of its deposition. Clod is an impurer, softer clay, having no distinct cleavage in any direction.

QUES. 3.—What is a "step" fault?

ANS.—A *step fault* is a fault of dislocation, in which the continuity of the seam is abruptly terminated, and the position of the corresponding strata upon opposite sides of the fault are, relatively, the one above or below the other. This has been caused by a fracture and movement of the earth's crust.

QUES. 4.—Describe and illustrate by a sketch, some method of working a coal field, with which you are familiar.

ANS.—This question can be answered best by referring to two



PLAN OF NO. 2 MINE, STAR COAL CO., KANGLEY, ILL.

or three articles previously published, describing the methods of mining in different states. The accompanying sketch shows a portion of the workings of No. 2 Mine, of the Star Coal Company at Kangley, Ill., and illustrates the common plan of room and pillar method of working, in use in this district. On Page 126,

October, 1900, is given a description of the different methods of working, employed in Iowa mines, which are also common to a greater or less extent in Illinois. On Page 195, December, 1900, is given a description of the methods of working common in Alabama. All of these methods refer to the working of soft coal seams of moderate thickness and generally flat.

QUES. 5.—The compass bearing of an entry is north 84 degrees 30 minutes east, and the declination at that point is 5 degrees east. What is the true bearing of the entry?

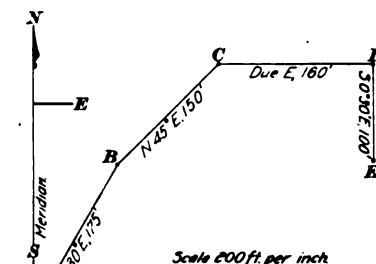
ANS.—Since the declination in this case is 5° E., the true meridian is to the left of the magnetic meridian, while the position of the entry is 84° 30' to the right of the same meridian. Hence the angle which this entry makes, with the true meridian is 84° 30' + 5° = 89° 30', and the true bearing of the entry is, therefore, N 89° 30' E.

QUES. 6.—What is the area included in 60° of a circle, the radius of which is 50 feet?

ANS.—The area of a full circle when the radius is 50 feet, is $3.1416 \times 50^2 = 7,854$ sq. ft. Since there are 360° in a full circle, the area corresponding to 60° of the given circle would be $\frac{60}{360} \times 7,854 = 1,309$ sq. ft.

QUES. 7.—Make a free hand sketch of the following portion

of a survey: A to B, N 30° E, 175 feet; B to C, N 45° E, 150 feet; C to D, N 90° E, 160 feet; and D to E, S 0° 30' E, 100 feet; using a scale of 1 inch to the foot. [We have inserted 30' in the last course of this survey, as there was evidently an omission in this respect, in the printed questions sent us.—EDITOR.]



ANS.—In the following plat of the survey, we have for convenience used a scale of 200 feet to the inch, instead of one foot to the inch, as the question asks, which makes the plat 1-200th of the size required.

QUES. 8.—What do you consider the best time of the year for cutting mine timbers? Give your reasons.

ANS.—This question is fully answered in the reply to Prize Contest Question 605, page 121, MINES AND MINERALS, October, 1900.

QUES. 9.—If a beam 5 feet between the points of support, bears a load of 6,000 pounds, when the same is uniformly distributed through its length, what weight will a beam of the same dimensions but 7 feet 6 inches between the points of support bear under like conditions?

ANS.—Since the weight which a beam will support under like conditions, varies inversely, as the distance between the points of support, we have $\frac{5}{7.5} \times 6,000 = 4,000$ lb., for the load which this beam will support, under the conditions stated.

QUES. 10.—What will be a safe working load for a steel hoisting rope of $\frac{1}{4}$ of an inch in diameter?

ANS.—Let W = safe working load (tons),
 d = diameter of rope (inches).

For high grade steel wire ropes (plough steel), the safe working load is expressed by the formula,

$$W = 8.65 d^2,$$

For cast steel, $W = 7.6 d^2$, to $6.6 d^2$,

For iron, $W = 5.3 d^2$.

For a $\frac{1}{4}$ " plough steel hoisting rope, the safe working load is, therefore,

$$W = 8.65 \times .875^2 = 6.6 \text{ tons.}$$

[This safe working load is not the net load which should be placed upon the rope, as it includes, also, the stress due to bending over the hoisting sheave above the shaft. Calling the diameter of the hoisting sheave D (inches), the formula expressing the net load hoisted, for 19-wire ropes, is

$$W = 8.65 d^2 - 380 \frac{d^3}{D}.$$

Assuming a 6-foot (72 inch) hoisting sheave, we have for the net load hoisted,

$$W = 8.65 \times .875^2 - 380 \frac{.875^3}{72} = 3.1 \text{ tons.}]$$

QUES. 11.—What load will a round iron bar of 1 inch in diameter carry, the tensile strength of the iron of which it is composed being 56,000 pounds?

ANS.—The sectional area of the bar is $.7854 \times 1^2 = .7854$ sq. in.; then $\frac{.7854 \times 56,000}{2,000} = 22 + \text{tons.}$

QUES. 12.—Which do you consider the best and safest device

for operating the safety catches of a hoisting cage, a spring or a weight and lever? Give the reasons for your answer.

Ans.—(1) Where the safety catches are operated by weights, their action, in case the rope is broken, is entirely dependent upon the fall of the weights attached to the ends of the arms or levers; and since the cage may fall as rapidly as the weights, there is no certainty of the catches being brought into action promptly and the cage prevented from falling to the bottom of the shaft.

(2) Where the catches are operated by springs, they are brought into action immediately, when the rope is broken. The strength of the spring will cause the catches to grip the guides promptly, and the cage is held securely in the shaft. Hence, spring safety catches are preferable, because they operate instantly, are simple in construction, and act independent of the laws of gravitation.

Ques. 13.—What is meant by the single, double and three entry system of operating and ventilating a coal mine?

Ans.—The three systems mentioned, relate to the number of passageways or headings that are driven together, in the coal, for the working of a single section of a mine or set of rooms or chambers. When a single entry or passageway is driven, and rooms turned from it, the system is known as the *single entry system*. In this case the ventilation of the rooms is accomplished, by causing the air to return along the face of the rooms, passing out through a breakthrough, onto the main entry.

The *double entry system* is a system in which the entries are driven in pairs. In this case one entry of each pair serves as the haulage road, and intake airway, while the other is used for the return of the air. In the *three entry*, or *triple entry system*, three parallel entries are driven together in the coal. In this case the middle entry of the three, is usually made the haulage road and the intake, the two outside entries being made the return airways for each side of the mine, respectively.

Ques. 14.—Why is the single entry system of operating almost certain to prove a failure?

Ans.—Because it is difficult to maintain a good return air-course at the working face; and because a fall occurring at the face of any of the rooms or upon the entry, cuts off the ventilation of all the rooms inside of such fall, and there is little chance of restoring the ventilation quickly under these circumstances.

Ques. 15.—Describe the various systems known to you by which a ventilating current may be produced in a mine.

Ans.—There are two general systems of producing a ventilating current in a mine. 1. By decreasing the pressure at the outlet of the mine. For example, in the use of a furnace, the air in the upcast or furnace shaft is rarefied and made lighter by the heat of the furnace, thus reducing the pressure at the foot of the shaft, due to the weight of the air-column in the shaft. Or, in the use of the exhaust fan at the mouth of the upcast shaft, the atmospheric pressure is reduced at the top of the shaft. Or, in the use of the steam blast, the air in the upcast is heated to a higher temperature by the steam and made lighter. In all of these cases the pressure at the foot of the upcast shaft is decreased. This causes a movement of the air through the airways from the downcast or intake of the mine toward the upcast or outlet. 2. Another method for producing an air-current in the airways of a mine, is to increase the pressure upon the air at the intake of the mine. This is done by means of the blowing fan, which, by its action establishes a pressure in the airway, greater than that of the atmosphere. Another example is found in the use of the water-fall or trompe, by which the pressure of the air at the intake is increased mechanically. In both of these cases, the air, as before, moves from a point of higher pressure toward a point of lower pressure, thus providing a current through the airways of the mine.

Ques. 16.—What power will be required to give a current of 60,000 cubic feet of air per minute in a mine in which there are four airways of equal length and section, each being 6 feet by 8 feet and 5,000 feet in length?

Ans.—Assuming that the air travels in four separate splits, the horsepower required to produce this ventilation is

$$H = \frac{k \log q}{a^3 \times 33,000} = \frac{.000000217 \times 4 \times 5,000 \times 2(6+8) \times 60,000^3}{(4 \times 6 \times 8)^3 \times 33,000} = 11.238 \text{ H. P.}$$

Ques. 17.—What pull is required to open a trap door 6 ft. $\times$ 6 ft. in size, the handle being 6 inches from the side, the pressure on the door showing a water gauge of $1\frac{1}{4}$ inches, and friction being neglected?

Ans.—The total pressure upon the door = $6 \times 6 \times 1.25 \times 5.2 = 234$ pounds. This pressure is exerted at the center of the door, and acts with a lever-arm of 3 feet. The lever arm of the pull is $6 - .5 = 5.5$ feet. In order to open the door the moment of the pull upon the handle at the start must be equal to the moment of the pressure exerted at the center of the door, and hence denoting the pull by P , we have,

$$P = \frac{234 \times 3}{5.5} = 127.64 \text{ lb.}$$

[See Prize Contest Question 623, page 218, MINES AND MINERALS, December, 1900.]

Ques. 18.—When is a regulator required in a mine?

Ans.—When it is desired to make a proportional division of the air current, or any division of the air current other than the natural division.

Ques. 19.—What is the law in reference to the division of a large mine into sections?

Ans.—The Illinois Revised Mining Law, section 19 (c), states as follows:

The main current of air shall be so split or subdivided as to give a separate current of reasonably pure air to every 10 men at work, and the inspector shall have authority to order separate currents for smaller groups of men, if in his judgment, special conditions make it necessary.

Ques. 20.—What is the law in reference to mine maps and escapement shafts?

Ans.—The law provides, Section 1, that a map shall be made of every mine, upon a scale, not smaller than 200 feet to the inch, showing the surface boundary line of the coal-rights; and all section or quarter-section lines or corners within the same; the lines of town-lots and streets; tracks and sidetracks of all railroads; also wagon roads, rivers, streams, ponds, buildings and other landmarks on the surface. The meridian and the scale must be given and the engineer or surveyor must certify upon the map as to the date and accuracy of the survey. The map shall be marked with the name of the mine, the company or owner, and the state, county and township where located. The map of the underground workings, must show all shafts, slopes, tunnels, or other openings, all excavations, entries, rooms and crosscuts; the location of the fan or furnace, and the direction of the air currents, location of pumps, hauling engines, engine planes, abandoned works, standing water and the boundary line of any outcropping of the seam. A separate map must be made for each separate seam worked. The surface and underground maps must be drawn upon separate sheets, the surface map being drawn upon tracing linen so that it can be superimposed upon the underground plan, to show the relative position of the buildings and surface lines and the underground workings. Each map must show the rise and dip of the seam, from the bottom of the shaft to the face of the workings.

The law provides, Section 3, for the making and maintaining of a second opening or *escapement shaft*, in every mine, in addition to the hoisting shaft or slope or drift; and allows three months for the building of such opening or escapement, for shafts 200 feet or less in depth; six months for shafts more than 200 feet and less than 500 feet deep; and nine months for all other mines, slopes, drifts, or connections with adjacent mines. In all cases the allotted time dates from the commencement of hoisting coal in the main shaft. The law makes unlawful the employment of more than 10 men, in any mine, previous to the completing of such second opening or escapement shaft. The distance between the hoisting shaft and the escapement shall not be less than 300 feet, except with the agreement and consent of the mine inspector of the district, and no inflammable structure, or powder magazine shall be erected between these two shafts.

Ques. 21.—What is the law in reference to mine examinations and the handling of blasting powder, or explosives in a mine?

Ans.—The law, Section 12 (c, d, e, f), makes it the duty of the mine inspectors to personally enter and examine every mine in their respective districts; and to see that every necessary precaution is taken, to insure the health and safety of the workmen employed in such mines, and to see that the provisions and requirements of the mining law of the state, are faithfully observed and kept, and the penalties enforced. The operator of every coal mine is required by law to furnish all necessary facilities for making such examinations; and in case of his refusal, the inspector must file his affidavit with the judge of the circuit court, of the county wherein the mine is located, or with the master in chancery, and obtain from him an order requiring the agent or operator to furnish such necessary facilities for the inspection of the said mine. The mine inspector shall post, at each mine visited, a notice stating the condition of the mine, and what he would recommend for its betterment. He shall also post a notice at the landing, stating what number of men will be permitted to ride on the cage at one time, and limiting the speed of hoisting and lowering men upon the cage.

Section 16 (d) makes unlawful the firing of shots, except in accordance with the rules of the mine. The mine manager shall direct the proper storage and handling of explosives in the mine; and the time and manner of placing and discharging all shots.

Ques. 22.—Give the characteristics of the various gases found in coal mines, describing how they may be distinguished the one from the other, and saying where they are severally likely to be found.

Ans.—Marsh gas, or carbureted hydrogen (CH_4) is lighter

than air, having a specific gravity of .559. It is combustible, burning with a pale blue flame, but does not support combustion. It is a colorless, odorless and tasteless gas. When mixed with air in the proportion of one part of gas to $5\frac{1}{2}$ parts of air, the mixture (firedamp) becomes explosive. As the proportion of air is increased beyond this point, the firedamp mixture is rendered more and more explosive, until the explosion reaches its greatest violence when the proportion of gas and air is 1 : 9 $\frac{1}{2}$. As the proportion is further increased beyond this point, the explosive violence of the firedamp is decreased, until it ceases altogether when the proportion of gas and air is 1 : 13 $\frac{1}{2}$. The gas diffuses rapidly into the atmosphere, forming firedamp. It is not poisonous, but when pure produces suffocation. When mixed with air, however, it may be breathed with impunity for a great length of time, producing only a slight giddiness, which passes off upon return to pure air. On account of its low specific gravity, this gas accumulates in the high places and upper portions of the mine workings. Its presence is detected by the small blue cap which it gives to the flame of a safety lamp, the height of this cap denoting the percentage of gas present. Other gases found in coal mines are as follows: Carbonic acid gas (blackdamp), CO_2 ; carbonic oxide gas (whitedamp), CO ; sulphureted hydrogen, (stinkdamp), H_2S ; afterdamp, which is a mixture of these several gases and the nitrogen of the air, occurring as the result of an explosion of mine gas. Carbonic acid gas owing to its high specific gravity is usually found near the floor and the lower portions of mine workings; while carbonic oxide gas and marsh gas accumulate near the roof and in the higher portions of the mine. Sulphureted hydrogen gas occurs from the decomposition of pyrites in coal measures, and accumulates at the floor of close, moist workings. The distinguishing characteristics of these gases are given in answer to Ques. 5, page 230, MINES AND MINERALS, December, 1900.

Ques. 23.—What is firedamp?

Ans.—The term firedamp, in America, is usually understood to mean any explosive mixture of marsh gas and air. In England, however, the term is often applied to any mixture of gas and air whatever, whether explosive or otherwise. Again, the term is sometimes applied to pure marsh gas, by those who are not well informed. The meaning first mentioned above, however, is the generally accepted meaning of the term.

Ques. 24.—What pressure, measured by the water gauge, should a theoretically perfect fan, 10 feet in diameter, make at a speed of 70 revolutions per minute, when running in a cloose speed?

Ans.—The formula in common use for determining the theoretical water gauge produced by a fan at a fixed speed, and delivering air into an airway is,

$$i = \frac{u^2 \times 12 \times 1.2}{g \times 1,000}.$$

In which i = water gauge (inches),
 u = tangential speed of fan (ft. per sec.),
 g = force of gravity (32.16).

Applying this formula to the present case, we have,

$$i = \left(\frac{3.1416 \times 10 \times 70}{60} \right)^2 \times \frac{12 \times 1.2}{32.16 \times 1,000} = .6015.$$

[This is the theoretical water gauge of this fan, when delivering air; the actual water gauge would probably be somewhat less than half of this amount, since by the use of this formula no fan can present a higher manometrical efficiency than .5.

The question of determining the static water gauge or the water gauge produced when the fan is discharging into a closed space, depends upon other data not given, as for example, the actual water gauge produced by the fan in generating a given velocity of air in the airway. When this is known the static water gauge due to the given speed of the fan may be determined by the formula,

$$\text{Static water gauge} = \frac{2g}{v} \times \text{actual water gauge}.$$

For example, the 12.5-foot $\times$ 10-foot Capell fan of the Berwind, White C. M. Company at their Eureka mine, No. 30, Scalp Level, Penna., produced a volume of practically 300,000 cubic feet of air per minute under a water gauge of 3.1 inches, at a speed of 200 revolutions per minute. Assuming an area of the airway about 150 square feet, the velocity of the air current would be 2,000 feet per minute, say 35 feet per second. Under these conditions applying the above formula, we find the static gauge due to the action of this fan,

$$\text{Static gauge} = \frac{2 \times 32.16}{35} \times 3.1 = 5.697 \text{ in.}$$

In the actual test of this fan when the fan drift was closed as tightly as it was possible to make it, the water gauge gave a reading of 5.6 inches (MINES AND MINERALS, February, 1898, page 318).]

Mine Examiners' Examination, Held at Springfield, Illinois, December 10, 1900.

Ques. 1.—What are the methods known to you for producing a ventilating current in a mine?

Ans.—See answer to Ques. 15, Mine Managers' Examination above.

Ques. 2.—What dangerous gases have you met with in your experience as a coal miner?

Ans.—If the candidate has had a full experience, he has probably met with the gases mentioned in the answer to Ques. 22 of the Mine Managers' Examination above.

Ques. 3.—What forms the most dangerous kind of roof, in coal mining, in this state?

Ans.—The most dangerous kind of roof met with, in coal mines in Illinois, or in any state, is that formed of a hard rock that does not break readily and containing slips. When these slips in the roof strata dip forward over the coal they are extremely dangerous, since the miner has no knowledge of their presence until too late.

Ques. 4.—From what source does the greatest number of accidents to life and limb arise, in the mines of this state?

Ans.—The most prolific source of accidents to miners is, falls of roof and coal, at the working face. See answer to Ques. 19, page 233, MINES AND MINERALS, December, 1900.

Ques. 5.—Explain the construction of the common safety lamp, and say who was its inventor.

Ans.—Sir Humphrey Davy is generally conceded to be the inventor of the safety lamp in its essential principle, which is the isolation of the flame from the outside atmosphere by means of a wire gauze.

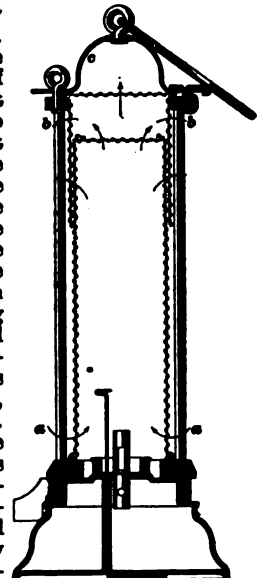
The lamp consists of a solid brass lamp or oil vessel, to which is attached a gauze cylinder, $5\frac{1}{2}$ inches high by $1\frac{1}{2}$ inches in diameter. The gauze mesh contains 784 openings to the square inch, made by 28 parallel wires crossing each other. This gauze is surmounted by a gauze cap completely enclosing the flame of the lamp, the cap increasing the height of the lamp to 6 inches. This gauze cap is double at the top where it is most liable to be burned through, or to become hot and pass the flame. The principle in this lamp, as in all safety lamps, is the isolation of the flame from the outside air, through the medium of the cold wire gauze. The gas and air surrounding the lamp enter through the gauze and burn within the lamp, but the flame in passing through the gauze is necessarily divided into minute jets of flame, and the temperature of each of these flame jets is lowered, by contact with the cold gauze, below the temperature of combustion. The flame is thus extinguished in the attempt to pass through the gauze. As long as the gauze is kept cool the isolation of the flame from the outside atmosphere is complete, the lamp is supplied with a lock fastening the gauze chimney to the body of the lamp. In the common Clanny lamp the lower part of the gauze is replaced by a glass chimney which improves the light.

Ques. 6.—What portions of a mine would you most carefully examine in your rounds as a Mine Examiner?

Ans.—The most careful attention should be given to those portions of the mine giving off gas, or where explosive conditions are liable to exist. Also, careful attention should be given to such portions as present dangerous conditions from weak or treacherous roof, or such portions as are difficult of ventilation or drainage. The ventilation, timbering, and drainage of a mine constitute the most important matters requiring the examiner's attention.

Ques. 7.—In a mine ventilated by two separate currents or air-splits of unequal length, and which generates considerable quantities of firedamp, a regulator is placed in the shorter airway, and stands when properly adjusted about half open. One morning in beginning your rounds you find the regulator standing open. What condition would you expect to exist in the mine, and what would you do under the circumstances?

Ans.—Under these conditions a reduced circulation would be produced in the longer airway, and as a result explosive conditions could be expected in the workings ventilated by the same. The first thing to do would be to increase as far as possible the ventilation in that portion of the mine, by closing the regulator somewhat more than half, and increasing the speed of the fan as



much as possible. The examination of the workings upon the longer air-course should then be commenced, following the air in its natural course. Extra precaution should be taken to see that there is no standing gas in any of the chambers or workings of the mine. It may be necessary to erect temporarily, extra brattices to circulate the air more completely around the faces of the rooms and chambers. Particular attention should be given to the examination of cavities in the roof, and of the higher portions of the mine workings, and where the chambers run to the rise.

Ques. 8.—What percentage of marsh gas in the air makes itself apparent in the safety lamp?

Ans.—In the use of the common Davy lamp for testing, the ordinary miner cannot detect much less than 3 per cent. of gas. With the Ashworth-Hepplewhite-Gray lamp 2 per cent. of gas is detected, and with the Wolf naphtha lamp it is claimed that 1% is easily detected and $\frac{1}{2}$ of 1% by an experienced person. Other forms of lamps for testing, however, as the Pieler lamp, or the Clowes hydrogen lamp, will readily detect as low as 0.2 per cent. of gas.

Ques. 9.—What are the requirements of the law in reference to trap doors and the Mine Examiners' report?

Ans.—Section 19 of the Revised Mining Law of Illinois, reads as follows:

(c) All permanent doors in mines used in guiding and directing the ventilating currents, shall be so hung and adjusted as to close automatically.
(f) At all principal doorways through which cars are hauled, an attendant shall be employed for the purpose of opening and closing said doors when trips of cars are passing to and from the workings. Places for shelter shall be provided at such doorways to protect the attendants from being injured by the cars while attending to their duties.

Section 12 reads as follows:

(i) Each State Inspector of Mines shall at the close of the official year, to wit: After June 30, of every year, prepare and forward to the Secretary of the Bureau of Labor Statistics, a formal report of his acts during the year, in the discharge of his duties, with any recommendations as to legislation he may deem necessary on the subject of mining, and shall collect and tabulate upon blanks furnished by said Secretary, all desired statistics of mines and miners within his district, to accompany said annual report.

Ques. 10.—How many cubic feet of marsh gas would require to be generated in a mine per minute to render dangerous a current of 30,000 cubic feet of air per minute?

Ans.—The lowest explosive limit of firedamp is reached when the proportion of gas to air is 1 : 5.5, and dangerous conditions may be considered as existing when the proportion of gas to air is 1 : 5. Since there are 30,000 cubic feet of air per minute in circulation, a quantity of $\frac{30,000}{5} = 6,000$ cubic feet of gas per

minute, will produce dangerous conditions in the mine. Indeed, a much less quantity of gas than this may be considered dangerous, since under certain conditions explosions may occur when the proportion of gas and air is considerably less than 1 : 5. These conditions are obtained when the firedamp mixture consists of other gases than pure marsh gas; also when coal dust is held in suspension in the atmosphere of the mine. Explosive conditions are often induced by concussion produced by the explosion of a blast, and at times by the sudden closing of a mine door, or other causes, when the percentage of gas present in the current is not within the explosive range. (See, Testing for Gas by Lamp Flame, MINES AND MINERALS, April, 1900, page 429; and Characteristics and Peculiarities of Mine Gases, July, 1900, page 570.)

Hoisting Engineers' Examination, Held at Springfield, Illinois, December 10, 1900.

Ques. 1.—What is meant by "clearance" in a cylinder?

Ans.—The term *clearance* in relation to a cylinder may have two meanings. (1) It may refer simply to the actual distance between the piston and the cylinder head when the former is at the end of its stroke. (2) The more usual meaning of the term, however, refers to the ratio which the volume of the steam space in the cylinder and the steam port up to the valve when the piston is at the end of its stroke, bears to the volume of the steam space in the cylinder and port on the same side of the piston when the latter is at the beginning of its stroke.

Ques. 2.—What part of a boiler is apt to weaken soonest?

Ans.—That portion of the boiler which is directly exposed to the fire; owing to the severity of the heat of the fire, and the tendency of the iron to blister. Other weak portions of the boiler are the points where the stay rods are bolted to the shell, or boiler plates are riveted together, since corrosion is more apt to take place at these points. A manhole or any opening cut in the boiler for steam or water connections, or for the steam dome, forms a weak point.

Ques. 3.—How do you proceed in cleaning a boiler?

Ans.—The fire is moderated and finally drawn. When the pressure has fallen to, say 10 or 15 pounds, the blow-off cock at the rear of the boiler or at the mud drum, as the case may be, is opened and the contents of the boiler blown out. After this has been done and the boiler has cooled, a careful examination of the

inside of the boiler is made to determine its condition with respect to corrosion and the amount of scale formed. Scale should not be allowed to form thicker than $\frac{1}{8}$ of an inch before removing the same. The scale is detached by scraping, and the entire surface of the shells and tubes are thoroughly cleaned and the dust removed through the manhole. Cleaning should be done as often as necessary, according to the condition of the feed water; but special attention should be given to the boiler when using a new feed water supply, until its action is ascertained.

Ques. 4.—What parts of a boiler require strengthening by means of stays?

Ans.—All the flat surfaces of the boiler, and particularly the boiler ends.

Ques. 5.—What is the cause of the formation of scale in a boiler, and how can the bad effects of scaling be prevented?

Ans.—The causes of the formation of scale or incrustation in boilers, are given in answer to Ques. 5, page 281, MINES AND MINERALS, January, 1901. The bad effects of scaling are best prevented (a) By preventing the formation of scale. (b) By the removal of the scale at regular intervals as it is formed. The several means of preventing incrustation may be enumerated under the following heads. 1. Filtration. 2. Frequent blow-off of the surface cocks, and regular blowing off of the boiler at such periods as experience shows to be necessary in each case. 3. Maintaining a thorough circulation in the boiler. 4. Heating the feed water. 5. Chemical treatment of the water in the boiler, or the introduction of a suitable amount of kerosene oil into the feed water. 6. Chemical treatment of the feedwater outside of the boiler when advisable. The method employed for the removal of boiler scale has been explained in answer to Ques. 3 above.

Ques. 6.—What power will be developed by an engine, 16" $\times$ 30", making 120 strokes per minute, the mean effective steam pressure being 50 pounds per square inch?

$$\text{Ans.— } H = \frac{50 \times 30 \times .7854 \times 16^2 \times 120}{12 \times 33,000} = 91.39 \text{ H. P.}$$

Ques. 7.—Which is the more economical of fuel, high pressure or low pressure steam?

Ans.—High pressure steam results in greater economy in fuel, since it means smaller engines and consequently smaller boilers, and a larger percentage of useful effect obtained from a given weight of steam. The efficiency of steam increases as its pressure is increased, hence the advantage of the use of high pressure steam.

Ques. 8.—What is the cause of pounding in an engine?

Ans.—The several causes giving rise to knocking or pounding in an engine are given in answer to Ques. 18, page 282, MINES AND MINERALS, January, 1901.

Ques. 9.—What would you do to stop a clicking noise in the cylinder?

Ans.—The clicking that frequently occurs in the cylinder of an engine is generally due to the steam pressure gaining access to the packing rings of the piston, causing the ends of these rings to strike together and produce a clicking sound. When this occurs it is a difficult matter to fully eradicate the trouble. When the trouble is due to other causes, as when the valve is lifted from its seat by too strong a compression in the cylinder, relief may be had by reducing the period of compression or applying such other needed remedy as a careful scrutiny may suggest.

Ques. 10.—How would you proceed to set a common slide valve?

Ans.—This question is fully answered in answer to Prize Contest question 641, page 315, MINES AND MINERALS, February, 1901.

Ques. 11.—How would you determine the point of admission of steam to an engine cylinder, and the point of cut-off?

Ans.—The points of admission and of cut-off are determined, respectively, from the indicator diagrams taken from the engine. It is often a difficult matter to determine exactly these points, especially when the engine has a leaky valve, or there is a rounding of the lines of the indicator card due to other causes. This is especially true at high rotative speeds. Experience is required and a thorough knowledge of the working of the engine, and the effects of compression and expansion in the cylinder. The point of admission on the indicator card is determined by the first evidence the card shows of compression having ceased. The point of cut-off is often more difficult to determine than that of admission, but it is usually accomplished by producing upward the expansion line of the card to where it intersects the line of the indicated diagram.

Experimentally the point of admission, in the stroke of an engine, may be determined by turning the engine over and noting the point when steam first enters the cylinder as indicated by its escape from the open drip-cocks; but time must be given for the steam to fill the cylinder. Likewise, the point of cut-off is ascertained by noting the point at which steam ceases to escape from the drip-cocks when the engine is turned over.

QUES. 12.—How would you fire your boilers to get the best results from them and from the fuel used?

Ans.—The firing of the boiler should be performed in as uniform a manner as possible. The coal should be evenly spread over the surface of the fire, in a thin layer, so as not to reduce the heat of the fire or render the same irregular. The firing should be done at regular short intervals. The greatest efficiency of a fuel is produced when there is an even combustion over the entire surface of the grate. The thickness of the bed of fuel should not be so great as to prevent the admission of the air, nor so thin as to allow the upward passage of cold air through the grate.

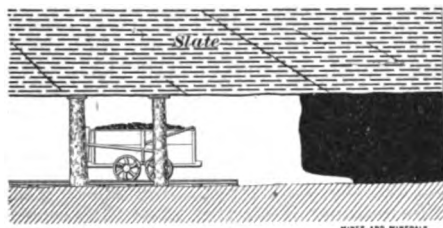
Dangerous Roof or "Top" in Coal Mining.

Even a cursory examination of almost any mine inspection report cannot fail to impress one with the large number of accidents occurring from falls of roof and coal. Of this class of accidents fully 90 per cent. occur in close proximity to the working face. This is the portion of the mine that is more particularly under the charge of the miner and for which he is responsible in a large measure. It is true that it is the duty of the mine foreman or pit boss to see that each working place is maintained in a safe condition, but with the supply of needed timber and a few hurried instructions to the miner the responsibility of the mine foreman ends and the work of setting timber at the face devolves upon the miner himself.

Many a miner has lost his life through the neglect to perform this work promptly. Familiarity with the dangers of mining does not tend to make the miner a competent judge as to whether the setting of a few posts is an immediate necessity or whether it may not be delayed until he has loaded out the coal of the night before. It is human nature to postpone dead work, or work that brings no apparent remuneration, until an idle time, or at least to give preference to work that counts. The "sticking up of a post" is a matter of so little moment to the busy miner that it is in general regarded by him as something that can be done at any time. A few careless raps with the end of his drill upon the rock above him and he goes to work with little thought of the actual danger that threatens. In nine cases out of ten a stone must give a very hollow sound to cause the miner to delay his other work for even a few moments and set a few posts that would render his place safe beyond question. If these remarks are facts, and truly represent the attitude of the miner toward his surroundings, it is not strange that so many of these men meet death

in their working places and have no one to blame but their own negligence or procrastination.

To an unintelligent miner all kinds of roof are the same if they present a similar appearance. He knows little and seems to care less



regarding the conditions that render a seemingly good roof "heavy"; he has no intelligent knowledge of the jointing in certain roof strata that renders such a roof extremely treacherous, and makes mining under it dangerous. He is wholly unconscious of conditions relative to the character of the roof strata above named, that make it possible for a thin roof slate or shale to settle away from a hard rock stratum above it. He is oblivious to the fact that above the thin stratum or roof there is forming an arch of rock that is supporting itself over a large area, and is liable at any moment to fall. He does not consider the circumstances that permit of a large increase of roof pressure due to an accumulation of water or gas above the roof slate. These, and many similar conditions by which the miner is continually surrounded, demand the closest study and consideration upon his part.

A dangerous roof is not always a weak roof or a roof that presents a broken and dangerous aspect to the view. One of the most dangerous roofs known to coal mining is that composed of a clod varying from 2 to 3 and at times 4 feet in thickness. This clod if allowed to fall in the rooms or chambers, would necessitate the handling of a large amount of dead material for which the miner would receive no pay, and his effort to hold it up during the life of his room is only partially successful. This roof becomes, as a general rule, very heavy before the room is driven up half way. Under these circumstances the distance that it is safe to drive the room is much lessened. In many mining districts, particularly in those of the Central Basin, such conditions occur locally in the mine and render the working of certain rooms extremely dangerous, but since the trouble affects a few of the rooms only, the general plan is not changed, the miner in these

cases being exposed to a danger which he does not realize. When this clod is thin and does not exceed, say, 12 or 18 inches, it is usually called a "dirt slate." In this case it is often an advantage in the mining of thin seams, since the entries are driven up in the coal and are not timbered close to the face, thus giving the dirt slate an opportunity to fall, which it does a few yards behind the entryman at the face. The falling of this slate gives the required head room in the entry.

Certain kinds of roof strata contain joints, or slips as they are frequently called, that render the work of mining dangerous. Especially is this the case when the slips dip forward over the coal instead of rising. In this case the miner has no knowledge that he is working under a loose stone. At any moment his mining may loosen the coal that holds the forward end of this jointed slate and allow it to fall upon him without warning. When the slip runs in the opposite direction, or rises over the coal, the miner is warned of the danger, as he sees the slip before the slate is loosened. See illustration.

In gaseous seams the settlement of the roof slate in the working of the coal vein permits the accumulation of a large body of gas above it. At times this gas is under considerable pressure, which adds to the weight of the roof and renders it more dangerous.

Much has been written and spoken in regard to systematic timbering as a means of averting the danger from falls of roof and coal to which the miner is daily exposed. There is no question but what systematic timbering is to be advocated in general mining practice, but as a means of averting danger we would suggest that a systematic time for timbering would be more effective. A good rule is that if timbering is needed at all it is needed at once, and not in an hour, or two hours, or tomorrow, and this rule adhered to would save more lives than any amount of system in the manner of placing timbers. In many kinds of roof, timbers must be placed where they are most needed; this is the case particularly in any form of broken, jointed roof. When boulders occur in the roof these require special timbers. In no case should the timber be set with the idea that it is to furnish a sufficient support to prevent the falling of the roof. When the depth of cover exceeds 100 yards no timbers can withstand the roof pressure which is liable to be thrown upon them. Every experienced miner knows that the object of room timbers is to furnish temporary support in the immediate vicinity of the roadway and the working face. The timber furnishes further an important index of the movement of the roof, and the careful miner will not neglect to examine the timber in his room from time to time, to acquaint himself with the action of the roof. It should not be attempted to hold up the roof over any considerable area. If the roof has a tendency to fall let it fall in the gob and waste places. This will relieve the pressure upon the pillars and will be a benefit. Under stronger roofs this cannot often be done, but the roof must be supported until the pillars are withdrawn, but in all cases a fall should then be induced. The writer recalls several instances when by neglecting to do this, and allowing the roof to stand supported over a considerable area, a squeeze or creep resulted that closed several pairs of entries. This is the natural result of the neglect to withdraw timber and induce a fall in the abandoned workings where the roof is strong.

In this connection a few words in regard to the manner of setting room timber will not be out of place. All room timber should be squared at both ends. It has been suggested by Mr. Hepplewhite that in hard roof and floor mine timbers should be tapered for a distance up from the bottom, greater or less, according to the character of the floor. By doing this the timber takes the weight gradually and is not broken as it otherwise would be; since the timber furs at the bottom. This is only another means of accomplishing the same thing as when a post is set upon an amount of soft compressible slack or dirt, since the same opportunity is thereby afforded for the timber to take the weight gradually as it is pressed into the soft dirt. This is an important factor and should always be borne in mind when setting room timber where the roof and floor are hard. The use of iron for wood in mine timbers has been tried in a few instances, but has not proven satisfactory, because the iron when loaded by a weight greater than it can support breaks without warning. What renders mine timber the most efficient is the warning or evidence that it gives of the pressure upon it.

In the Dortmund coal fields German statistics of winding ropes have been systematically kept since 1872. Of the 6,461 winding ropes discarded the following broke suddenly while in use:

Of 881 round iron ropes	105 or 11.95 per cent.
Of 4,467 cast steel round ropes	88 or 1.86 per cent.
Of 147 flat iron ropes	19 or 12.93 per cent.
Of 826 cast steel flat ropes	48 or 5.81 per cent.
Of 97 aloof flat ropes	7 or 7.22 per cent.
Of 8 hemp flat ropes	

Total of 6461 winding ropes..... 262 or 4.06 per cent.

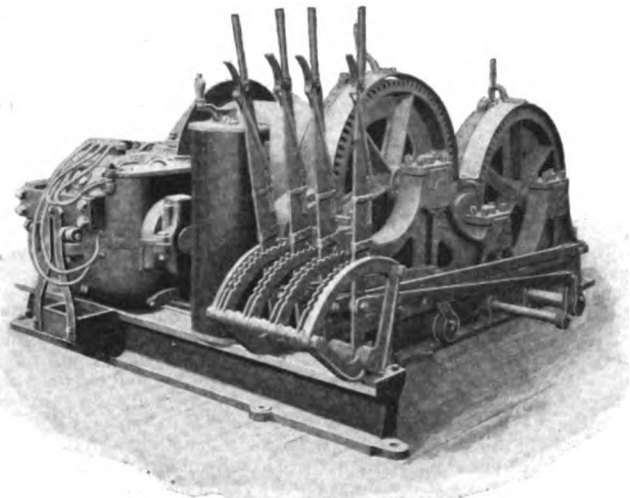
Electric Hoisting Engines.

The superior advantage of the electric hoist, as compared with steam, especially for inside rope haulage, and many other places, is too obvious to require comment.

It is therefore desired to call particular attention to some of the special features of the electric hoist illustrated by the accompanying picture, which represents one of the S. Flory Mfg. Co.'s improved mine and quarry hoists. They are made with single, double, or multiple drums, either tandem or side by side, according to preference of purchaser.

In its design all the good features of the steam hoist were retained and other improvements were added to combine strength, efficiency and simplicity of operation.

The levers, for controlling the frictions and brakes of the drums, are assembled in a battery on quadrants, near the con-



ELECTRIC HOISTING ENGINE.

troller, for convenience and reliability of operation. Easy access is provided to all parts for inspection, lubricating etc., and so far as practicable the parts are made to duplicate.

The device for releasing the friction consists of yokes and rods forming a positive connection between the friction screw and the drum, obviating the trouble of sticking, often the case where only a recoil spring is used between the gear and drum flange.

These hoists are fitted with modern type motors of the highest efficiency, at a minimum consumption of current. The controllers are also of the most approved type and the levers arranged as described above assure easy and perfect control of the machine.

For further particulars interested parties are requested to address S. Flory Mfg. Co., Bangor, Pa.

Co-Owners of Patents.

Walter Brown.

The following statement presents a summary of the present condition of the law relating to co-ownership of patents:

When several persons together own a patent, and they have not entered into a contract which precisely defines the rights of each, the share in the profits to which each is entitled, etc., then each of those persons may grant licenses without the consent of the others, and the others cannot prevent the licensee of the one part-owner from making and selling the article under his license.

It seems, however, that one part-owner of a patent cannot grant an exclusive license without the consent of the others; and, of course, no one should take an exclusive license without having that license in writing and executed by all the part-owners of the patent. This is a reasonable precaution which no sensible business man would neglect.

Each of the part-owners may also work the patent to any extent, by manufacture, sale and use of the invention, without the consent of the other part-owners, and those others cannot restrain him doing so. The courts will not issue an injunction at the instance of one or more part-owners to restrain another from working the patent or from granting licenses which are not exclusive, and it is doubtful whether they would enjoin him from granting a license that purported to be exclusive.

Whether, if one part-owner of patent receives a profit by working the invention or granting licenses under the patent, he can be compelled to account to the other part-owners and pay over to them their proportionate shares of the profits is doubtful.

But, upon the whole, the courts incline to the following view: (a) A part-owner cannot be required to account for and pay over to the other part-owners any part of the profits he has made out of the working of the invention. (b) A part-owner will be compelled to account for and pay over to the other part-owners their proportionate shares of the profits he has received from the granting of licenses.

Related to the question of the co-ownership of patents is that of the rights of partners to inventions made by a member of the partnership, though this question is perhaps even more strictly related to that of employers and employees. I shall, however, give a summary of the law here.

Generally and in the absence of special agreements otherwise, an invention made by a member of a partnership is the exclusive property of that member, and the patent when granted belongs solely to him. Even if the funds for prosecuting the application for the patent, making experiments and the like are paid by the partnership, that fact does not make the invention or patent partnership property.

If, however, the patentee allows the invention to be used in the firm's business, then a license to the firm will be created, and if the article of partnership provided that the firm should continue after the death or withdrawal of the patentee from the firm, the license so created would continue until the partnership was dissolved.

This license is, however, a license to the partnership, not a license to the individual members of the firm; and where it arises, it terminates on the dissolution of the partnership, and the members, other than the patentee, have thereafter no license to make, use, or sell the invention.

What may seem to be an exception to this last statement sometimes occurs where the invention is of such a character as to be applied to articles such as machines, in which the firm deals or which it uses in its business. In such a case, if the invention has been applied to such articles with the consent of the patentee, before the dissolution of the firm, and, upon dissolution, those articles became the property of individual partners, then those individuals acquire a license to use the invention in connection with such articles. To illustrate these principles: A member of a partnership invented and patented a device which was put on certain steamboats which were used by the firm. Upon the dissolution of the partnership, one of the partners took one or more steamboats at an agreed valuation. It was held that he had a license to use the invention on that boat, but not to put the invention on a new boat.—*Power*, January, 1901.

Pittsburgh Rotating Gage Cock.

Probably no appliance attached to the steam boiler has greater utility than the gage cock. The Pittsburgh Gage & Supply Co., Pittsburgh, Pa., manufactures a rotating gage cock that covers the field of the original siphon compression gage cock, and has other features which relieve the engineer of annoyance. This gage cock is operated by pulling down the lever to which a chain is attached of any length required, which enables the cock to be placed at any height, or in any position difficult to reach. When the cock is opened, which is done automatically by pulling down the lever, the steam or water passing through the spiral causes the stem to revolve rapidly, cleansing the interior of the cock, preventing the formation of sediment, and when allowed to go back to its valve seat, which is done by releasing the lever, grinds it true and clean. This action is positive, as the steam or water cannot pass through the spiral without causing it to rotate. The spiral, being placed before the valve seat, is protected from collection of sediment or corrosion, always allowing the stem to rotate freely. Another feature is the claw lever, which holds the valve firmly to its seat without interfering with the opening of the cock or the rotation of the stem when the cock is in use. No regrinding is necessary, and there is no wearing out of the valve seat, no replacing of discs and no leaking. Over 75,000 of these gage cocks are in use, and the manufacturers report a constantly increasing demand for them from all sections, including some of the largest steam plants in the country.

For further particulars and literature apply to the Pittsburgh Gage & Supply Co., Pittsburgh, Pa.



NEW INVENTIONS.

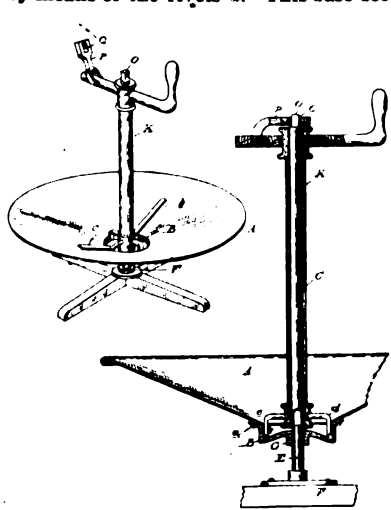
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

Single copies.....	5 cents each.
Copies by subclasses.....	3 cents each.
Copies by classes.....	2 cents each.
An entire set of patents.....	1 cent each.

GOLD PAN.

No. 663,296. D. B. NEWKIRK, DETROIT, MICH. *Patented Dec. 4, 1900.* The pan is conical in form and composed of sheet metal. Attached to the center of the bottom of the pan there is a base section *B* riveted on by means of the rivets *a*. This base section is provided with a hub *G*

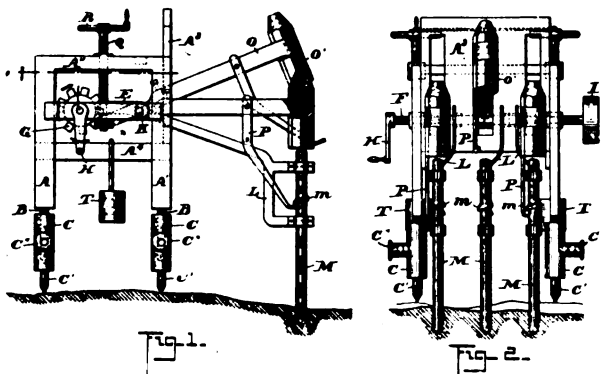


into which is screwed the spindle *C*. The lower end of this spindle is hollow and rests upon a pivot or pin *E* supported upon a plate *F* supported by any suitable base, as shown. When the spindle *C* is revolved the pan will revolve with it. The spindle *C* is surrounded by a sleeve *K*, on the lower end of which are attached arms *d* and *e* and *b* and *c*, the former turning down into the base section and the latter passing up over the surface of the pan *A*. Attached to the top of the sleeve *K* there is a crank arm and crank *L* by means of which it may be rotated and the central spindle *C* is provided with a square *O* at its upper extremity which may be attached to the crank arm by means of the piece *P* having a rectangular slot *Q* provided to fit over the

square *O*. To use the apparatus the pan is submerged below the surface of the water, filled with the material from which the gold is to be separated, the piece *P* thrown back as shown in Fig. 1, the handle *L* rotated so as to stir the contents and work the gold down into the sub-base. After the material is freed from gold it is discharged from the pan by throwing the piece *P* into position shown in Fig. 2 and rotating the handle rapidly so as to throw the earth out of the pan by centrifugal force.

HAND DRILLING MACHINE FOR DRILLING STONE.

No. 665,364. C. M. ENGSTRON, OSSISPEE, NEW HAMPSHIRE. *Patented January 1, 1901.* This patent covers a special rock drilling machine intended for drilling holes in groups of three, arranged in a straight line, as is done in quarrying. The various parts are illustrated in the accompanying figures. A suitable frame is provided, composed of uprights *A* and *A'* connected by cross pieces *A''* and *A'''*. The front of

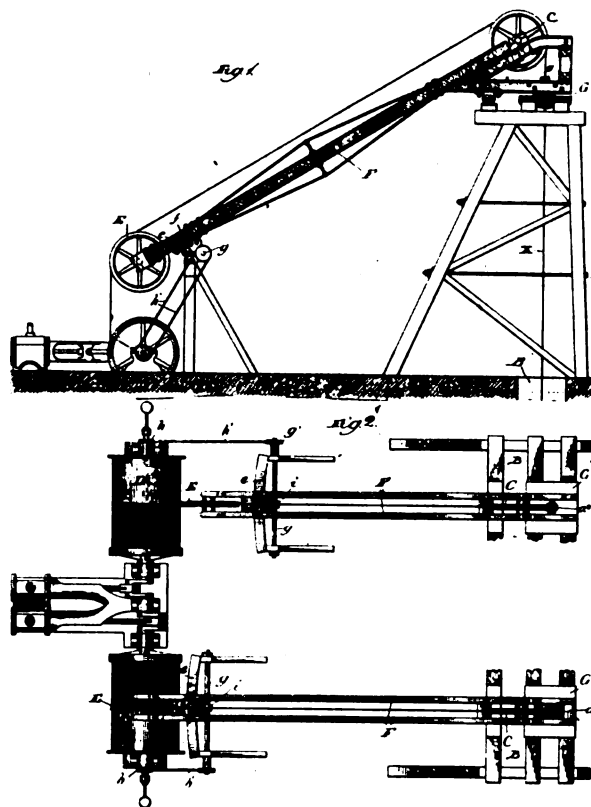


the frame is provided with a large rectangular plate *A²*, the lower portion of the frame is fitted with screws *B* which fit into sockets *C* armed with points *C'* and provided with openings *C''* into which a bar can be placed to screw the piece *C* along the threaded rods *B* so as to adjust the machine and enable it to stand on irregular ground. The drills *M* are supported in frames *L* and are struck by hammer heads *O'* carried on rods *O*. These hammers are actuated by three cams *G*, each having three teeth and so set that the hammers fall one after the other. The shaft *F* carrying these cams *G* may be operated by the crank *H* or by the band wheel *I*. The arms *O* are guided in slots in the front plate *A²*, as shown in Fig. 2. The drill is rotated by an arm *P* which engages the spiral *m* on the drill *M*. In case the weight of the machine is not

sufficient to hold it rigidly upon the rock, weights *T* may be hung from the frame. The portion of the frame carrying the cam shaft *E* and the pivot shaft *K* upon which the hammers are hung is carried upon the supports *E* and can be moved up and down by means of the screw *Q* and hand wheel *R*, thus making provision for feeding the drills down.

HOISTING MACHINERY.

No. 664,073. H. C. BEHR, SAN FRANCISCO, CAL. *Patented December 18, 1900.* This device is intended to overcome one of the difficulties met with in hoisting from deep shafts. It is always advantageous to have the hoisting drum of as small diameter as is consistent with the rope being employed, since this simplifies the connection with the engine; a smaller engine being able to do the work, and there being no necessity for gearing between the engine and the drum. To make a small drum hold a large amount of rope it must have a very wide face and the fleet of the rope becomes so great that it is difficult to keep it from piling up and winding upon itself. To guide the rope as it is laid onto the drum, the inventor provides a frame *F* pivoted by means of a suitable bearing upon the plate *G* so that it will swivel about the socket *a* through which the rope descends into the shaft *B*. For convenience in illustration the two shafts have been separated in Fig. 2, the engines being placed between the drums. The lower end of the frame *F* is carried upon rollers *f* traveling upon a bracket *e* so that the sheave *E* is always in line with the sheave *C*. One of the sheaves *E* is so placed that it will lay the rope on the front face of the drum *D* and the other so that it will lay the rope on the back face of the drum *D*, thus allowing one drum to pay out rope while the other is winding it on. In order to



carry the sheaves *E* across the face of the drums *D* screws *g* are provided which are connected by means of sprocket chains *h'* to suitable sprocket wheels *h* on the drum shaft. These screws *g* engage nuts at *i* upon the frame *F* thus carrying the end of the frame and the shaft *E* across the face of the drum as the latter revolves.

AUTOMATIC TAILINGS SAMPLER.

No. 665,620. W. STEPHENS AND J. P. MUNGER, JAMESTOWN, CAL. *Patented January 8, 1901.* This device covered is intended for automatically sampling tailings as they flow through a launder. Fig. 1 shows a side view of the apparatus partially in section and Fig. 2 an end view. *A* represents the launder, *4* represents a drum, supported on a shaft *3* and held in place by collars *5*. From the circumference of this drum blades *6* are arranged so that the pulp or tailings flowing in the direction of the arrow down over the curved portion *2* will cause the wheel to rotate. In order to prevent the wheel from running too fast the drum *4* is made hollow and provided with veins *7* on the inside and a suitable amount of water or pulp is added to the inside of the drum which in flowing over the veins *7* gives the desired resistance. At suitable intervals about the wheel special paddles or veins *9* are introduced. These are provided with slots *11* in their front faces, the inside edge of the slots being turned up as indicated by the dotted lines at *12*. The edges of the paddles *9* are turned forward as shown at *10* so that the pulp or tailings is turned up against the slots *11*; some of it passes through into the hollow paddles and as the latter ascend the left hand side of the wheel a small amount of this pulp is retained in the hollow

paddle by the projections 18. When these special paddles reach the upper position the pulp retained by the wings 12 flows down against the inclined partition 13 and out through the opening 15 at the side of

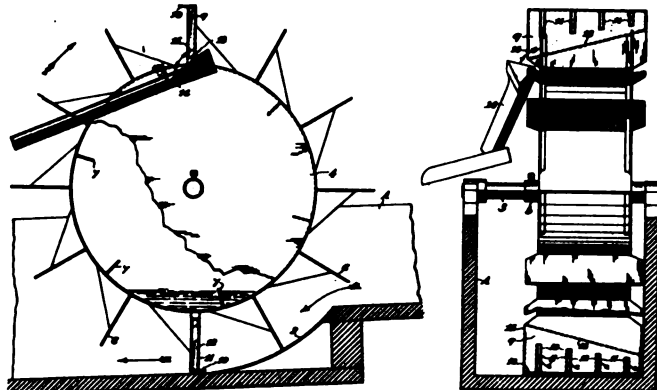


Fig. 1.

Fig. 2.

the blade, such pulp being received by the launder 14 by which it is conveyed to the receptacle for receiving the samples.

PROSPECTING PAN.

No. 664,066. J. TOBIN, NEW YORK, N. Y. *Patented December 18, 1900.* This patent covers a device for preventing the gold from being washed over the edge of a prospecting pan during the first stages of the washing process. An ordinary pan 10 is provided with a shield 12

Fig. 1.

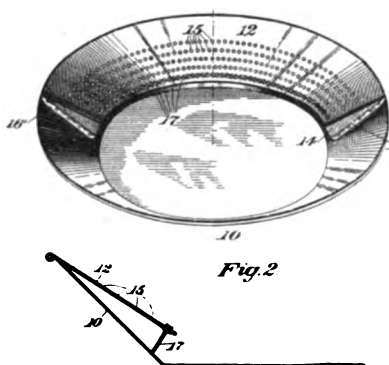


Fig. 2.

which extends part way around the pan, as shown in Fig. 1. This shield is fastened to the rim of the pan by soldering or by any other suitable means and at its end it is turned down as shown at 14 and provided with flanges 16 which are riveted to the sides of the pan. The shield is perforated with holes 15. During washing, the material is first treated on the side of the pan having the shield, the gold and heavier portions passing under the shield 12 and accumulating between it and the side of the pan 10. In order to prevent large stones from passing under the pan, screws 17 are placed along the edge of the shield 12, Figs. 1 and 2. These screws also serve to adjust the space between the pan and the shield and by removing every alternate or any other number of screws the width of the spaces between can be adjusted. It is claimed that the gold will accumulate between the shield 12 and the pan, while the major portion of the worthless material is washed away, after which the gold is washed out from under the shield and treated on the smooth side of the pan as in ordinary practice.

GOLD SEPARATOR.

No. 663,993. W. W. M. HICKEY, SAN FRANCISCO, CAL. *Patented Dec. 18, 1900.* This device is for treating gold-bearing gravel or similar material, either wet or dry. A is a frame supporting the apparatus, 2 the hopper into which the gold-bearing material is introduced, and from which it is washed onto the screen 3, which is attached to the frame 4. Clamped to the bottom of the frame 4 is a frame 5 carrying the amalgamated plate 6. Across the face of the amalgamated plate 6 a series of riffles 7 are arranged. The frames 4 and 5 are united firmly together and are hung by straps 8 so that they can be given an oscillating motion. Under these frames there is a discharge spout 9. The frames 4 and 5 are given oscillating motion by means of the pitman rod 10 which connects to a suitable crank at 19. The material which is introduced into the hopper 2 passes onto the screen, the finer portion being washed through to the amalgamated plate and the coarser portion passing through the discharge end of the screen. The worthless material in the finer portion is washed over the riffles onto the discharge spout 9, while the gold is caught on the amalgamated plate and behind the riffles. Under the end of

Fig. 1.

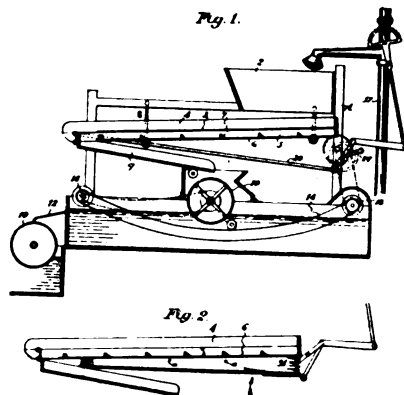


Fig. 2.

at 19. The material which is introduced into the hopper 2 passes onto the screen, the finer portion being washed through to the amalgamated plate and the coarser portion passing through the discharge end of the screen. The worthless material in the finer portion is washed over the riffles onto the discharge spout 9, while the gold is caught on the amalgamated plate and behind the riffles. Under the end of

the discharge spout 9 there is arranged an amalgamated drum 10 upon which the discharging material falls. This short fall causes an impact which would bring any particles of gold into contact with the drum and thus amalgamate them. The drum 10 is so placed that its lower portion runs in water in a trough as shown. Passing under the drum there is a discharging belt 14 running over the rollers 13 and so arranged that it will discharge the material onto the apron 12 at the discharge end of the machine. In order to provide a circulation of water a pipe 17 is arranged at one end fitted with a pump also operated from the shaft 19 which discharges a constant stream of water through the rose nozzle shown over the hopper 2. If water is scarce the pump may draw its supply from the troughs under the machine, thus utilizing the water to the greatest possible extent. In case water is very scarce the upper portion of the machine may be arranged as shown in Fig. 2, in which the amalgamated plate 6 is perforated with small holes and has a bellows 31 arranged beneath it, the bellows being operated from the crank shaft 19, Fig. 1. This set of bellows forces pulsating currents of air through the amalgamated plate screen and the material upon it thus causing the barren portion to discharge over the riffles while the gold is retained on the amalgamated plate or behind the riffles.

PATENTS ISSUED DURING JANUARY AND NOT ILLUSTRATED.

- Nos. 664,851 and 664,852. Centrifugal grinding machine, W. W. Green, Chicago, Ill.
 No. 665,026. Well-drilling machinery, G. D. Loomis, Tiffin, O.
 No. 665,106. Process of extracting gold and silver from ores, J. C. Kessler, Milwaukee, Wis.
 No. 665,162. Skimming-trough for blast-furnaces, F. E. Bachman, Buffalo, N. Y.
 No. 665,183. Mining-machine, F. J. Crane, Cripple Creek, Colo.
 No. 665,185. Rock-drill sharpener, R. M. Crockett and H. J. Bundy, Moscow, Idaho.
 No. 665,254. Lining for crucibles, W. A. McAdams, New York, N. Y.
 No. 665,262. Screw conveyor, S. B. Peck, Chicago, Ill.
 No. 665,339. Ore granulator and pulverizer, J. M. Montgomery, Butte, Mont.
 No. 665,061. Hoisting and dumping bucket, J. Carson, New York, N. Y.
 No. 665,250. Flue, E. H. Messiter, Leadville, Colo.
 No. 665,418. Amalgamator, G. W. Fisher, Louisville, Ken.
 No. 665,432. Blast-furnace, H. Hardh, Cleveland, O.
 No. 665,463. Coal-tipple, J. M. Phillips and J. J. Fleming, Pittsburgh, Pa.
 No. 665,574. Hoisting and dumping apparatus, C. A. Morris, Glen Ridge, N. J.
 No. 665,682. Excavator-bucket, No. 665,685. Excavator, O. Hetle-saeter, Chicago, Ill.
 No. 665,704. Electric furnace, G. S. Strong, N. Y.
 No. 665,711. Rock drill, O. G. Worsley, Newark, N. J.
 No. 665,717. Apparatus for melting iridium, G. Armeny, New York, N. Y.
 No. 665,744. Process of treating sulphide ores, H. F. Kirkpatrick-Picard, London, Eng.
 No. 665,773. Gold-saving apparatus, F. J. Drake, San Francisco, Cal.
 No. 665,823. Cage-chair for mines, M. H. Beck and J. R. Caynor, Victor, Colo.
 No. 665,835. Sand-washing apparatus, J. M. Miller, Washington, D. C.
 No. 665,880. Crucible or retort, A. A. Crosby, Chicago, Ill.
 No. 665,915. Process of electrolytic production of nickel or allied metals, M. Kugel, Berlin, Germany.
 No. 665,919. Fume-condensing apparatus and fuel-accumulator for smelting furnaces, C. C. Loder, Denver, Colo.
 No. 665,935. Decorticating and disintegrating machine, A. J. Rudolph, Chicago, Ill.
 No. 665,972. Fuel-compressor, No. 665,973. Method of making blocks of fuel, No. 665,974. Composition fuel, W. A. Patterson, Dallas, Tex.
 No. 666,001. Grinding-mill, G. M. Ditto, Joliet, Ill.
 No. 666,002. Ore-concentrating table, W. G. Dodd, San Francisco, Cal.
 No. 666,033. Gas-generator, F. L. Slocum, Pittsburgh, Pa.
 No. 666,050. Gold and ore sizing machine, W. Gray, Lincoln, Neb.
 No. 666,123. Furnace charging apparatus, S. T. Wellman, C. H. Wellman, and J. W. Seaver, Cleveland, O.
 No. 666,129. Crusher, E. D. Chester, London, Eng.
 No. 666,155. Metallurgical furnace, A. Reynolds, Sheffield, Eng.
 No. 666,229. Manufacture of anthracite briquets, P. R. de F. D'Humy, Liverpool, Eng.
 No. 666,163. Pulley system for conveyor belts, etc., No. 666,164. Roller mechanism for conveyor belts, J. Titus, Oyster Bay, and W. Titus, N. Hempstead, N. Y.
 No. 666,367. Apparatus for casting iron, R. H. Wainford, Stoke-on-Trent, Eng.
 No. 666,373. Skimming-trough, D. Baker, Chicago, Ill.
 No. 666,388. Caisson, W. H. McFadden, Pittsburgh, Pa.
 No. 666,390. Regenerative retort-heating furnace, C. F. Neureuther, Peru, Ill.
 No. 666,541. Well-packer, F. J. Moser, Kane, Pa.
 No. 666,597. Apparatus for treating zinc ores, S. G. Bridges, Kansas City, Mo.
 No. 666,796. Ore washing and concentrating machine, C. Brash, Victoria, Can.
 No. 666,799. Force-jet device for cleaning quarrying-holes, etc., S. W. Buckwalter and H. F. Buckwalter, Reading, Pa.
 No. 666,862. Apparatus for burning pulverized fuel, G. S. Emerick, Philadelphia, Pa.
 No. 666,892. Crushing-roll, P. Argall, Denver, Colo.
 No. 666,978. Apparatus for fuel-dust condensation, R. Ruetschi, Argentine, Kan.

Mines and Minerals

A MINING AND METALLURGICAL JOURNAL.

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THE NEW COKE PLANT

Of The Eureka Fuel Company in the Klondike Region,
Pennsylvania, A Complete Modern Plant.

Written for MINES AND MINERALS, by J. P. Brennan.

In 1899, the Illinois Steel Company bought, through Mr. C. H. Foote, the coal field that is now being operated under the name of

the Eureka Fuel Company. This field lies in Nicholson, German and Menallen Townships, Fayette County, Pennsylvania, on the eastern slope of the Fayette Basin of the Pittsburgh coal vein, and extends to within 1,000 feet of the Connellsville field at the Revere tract, now owned and operated by W. J. Rainey. It comprises about 6,500 acres, extending about nine miles in a north and south direction.

The dip of the vein through this field is approximately N 65° E, varying from 3.5 to 6 feet per 100. Along the eastern limits of the field, the coal has comparatively light cover, the vein being eroded in the valleys of streams, giving in many places, ideal conditions for the development of drift mines, while on the west, the vein lies at a depth requiring shafts to reach the coal. The preliminary surveys for the development were begun July 1, 1899, the first work being surveys for contour maps at the points selected for the three plants. Upon these maps the location of the pit mouths, coke ovens, power plants, railroad tracks and other accessories was determined.

Ground was broken for the pit mouth of No. 1 Mine at Leckrone in August, 1899; the contract for the coke ovens was let in September, 1899, and the first coke drawn June 2, 1900. The

work was carried on continuously through the winter upon oven construction, mine development, tenement houses, foundation work, etc.

Work at the Footedale plant was commenced in January, 1900, and at the Buffington plant, February 1, 1900.

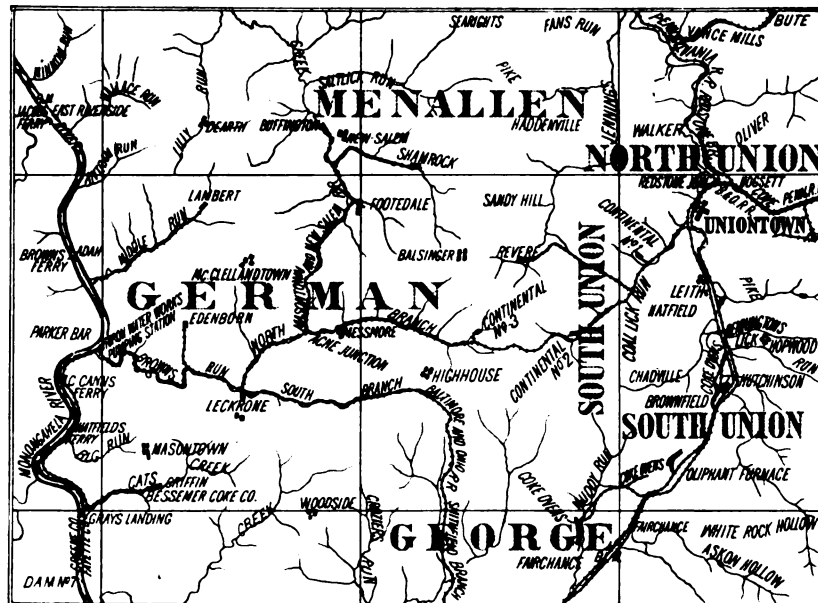
The nearest railroad delivery, until the Smithfield & Mason-town Branch of the Baltimore & Ohio Railroad Co. reached Leckrone (April 7, 1900), was for Leckrone, Smithfield, seven miles distant, and for Footedale and Buffington, Uniontown, five and six miles respectively, from which points all construction materials and machinery, including six 11-ton boilers, were hauled by team.

DESCRIPTION OF PLANTS.

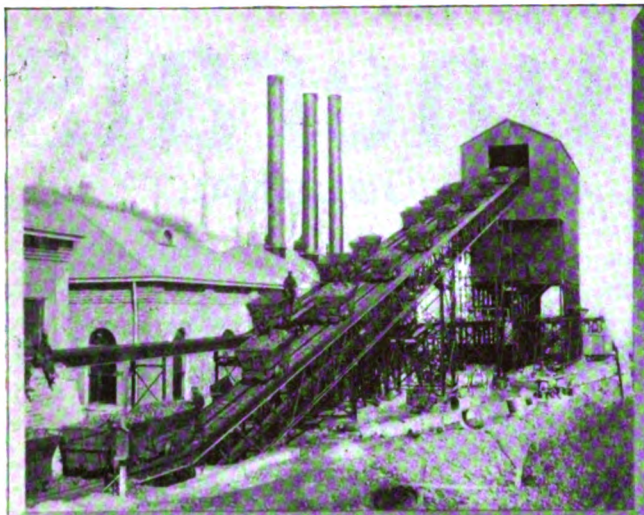
At Leckrone, at the forks of Brown Run, and two miles northeast of Masontown, there are two drift mines. The No. 1 Mine has 525 acres of coal tributary to it, all of which is self-draining, and grades on the haulage roads in favor of the load, the grade on the main haulage driven on the butt being 3.5%. The mine is equipped for the use of electricity. Electric chain machines are used for driving headings, and to a certain extent, in room work. The main headings are lighted with incandescent lamps, and electric locomotives will be used. The main haulage

roads are laid with 55 lb. steel and the butt headings with 25 lb., the rooms being driven on the face. A stone masonry retaining wall forms the pit mouth, and brick arches are carried in on all headings to the point where good roof is secured in the coal. Ventilation is provided for by a Capell fan, 13½ ft. diameter by 7 ft. wide, with a guaranteed capacity of 300,000 cubic feet of air per minute.

From the pit mouth the mine cars run by gravity 550 feet to the foot of the incline, whence they are hauled up the incline to the tippie by a sprocket chain, driven by an electric motor;



MAP OF KLONDIKE COKE REGION, FAYETTE COUNTY, PA.



No. 1 TIPPIL COMPLETED.
No. 2 TIPPIL COMPLETED.

dogs on the chain engaging in brackets on the bottoms of the cars. The length of the incline is 250 feet, with a grade of 25%, and the dogs are spaced so that eleven wagons can be placed on the chain at once. The cars are emptied into the bin by two Phillips dumps, the empty wagons being delivered automatically to the top of the incline again, where they are conveyed to the bottom of the incline by a similar sprocket chain running in the reverse direction. From the foot of the incline, the cars run by gravity to the pit mouth, the track being on an embankment separated from the loaded track by a masonry wall.

The bin has a capacity of 1,000 tons. It is 60 feet high from top of foundation to dumping floor, and 17½ feet from foundations to rail of larry track under bin. It is a steel structure throughout, designed both as to structural and mechanical details by Heyl & Patterson of Pittsburgh, Pa., who were also the contractors and erectors of all the machinery for the hoisting and dumping of the coal, the Schultz Bridge & Iron Company, of Pittsburgh, Pa., being the contractors for the structural work. Provisions are also made for the loading of screened coal into cars, and independent sidings are laid for the economical handling of same. This electrically driven chain hoist is a thoroughly modern and successful mechanical device for raising the coal to the tippel, and is somewhat of a departure from the usual location of a tippel for drift mines, as it makes it possible to select the lowest available point on the outcrop for pit mouths, and thus work the greatest possible acreage to the rise. One man and two boys are required to operate this hoist—one boy to place the cars on the chain at the bottom, one man to dump the cars on the tippel, and a boy to couple up the empty trips.

A steel trestle, 200 feet long, carries the track for the larrys from the bin to the ovens. Each larry is provided with an electric motor, the trolley wire on the ovens being carried on gas pipe poles attached at the bottom to an extension to the cast-iron ties under the rails. The ovens are built on a 1% grade, in favor of

the loaded larry and loaded coke car. The ovens are of the double-block type, 12½ feet in diameter.

The coke yards are 33 feet wide. A noticeable feature is the high yard walls, 10 feet above the loading track. These high walls, in conjunction with the special pressed steel coke racks, which are used exclusively for shipping coke from the plants of the Eureka Fuel Company, make the loading unusually easy for the coke drawer, the runs to the tops of cars being level, instead of up-grade, as is common with the low wharf walls.

There are 250 beehive ovens supplied from the No. 1 Mine.

The Leckrone No. 2 Mine has 300 acres of coal tributary, and supplies 150 ovens. In general features, the No. 2 plant is similar to the No. 1. The pit mouth is at a lower elevation, being but 5 feet above the general level of the valley, thus requiring a longer incline to reach tippel elevation. The distance from pit mouth to foot of incline is 350 feet, and the length of the incline 330 feet.

The Capell fan for the No. 2 mine is 8 ft. diameter × 3½ ft. wide, driven by a 25 horsepower, slow speed electric motor, with a guaranteed capacity of 90,000 cubic feet of air per minute.

As has already been stated, electricity is the form of power used almost exclusively at this plant. The generative plant is in duplicate, and consists of two General Electric Co. 165-KW, 275-volt compound-wound, direct-current generators, direct-connected to two Buckeye 240-horsepower 18½" × 18" engines. But one of the generators is required for the operation of the plant at the present time; but the two engines can be run in conjunction, and the power house is of sufficient size to allow the erection of two more engines and generators, should the future extension of the workings require it.

Steam is supplied by six 150-horsepower 6 ft. × 20 ft. tubular boilers, four boilers being usually in operation and two in reserve.

The general machine shop for the several plants is located at Leckrone. It is a building 48 ft. × 100 ft., divided into carpenter



No. 1 PIT MOUTH AND COMPLETED FAN,
No. 2 PIT MOUTH.

shop, machine shop, and blacksmith shop. The shops are equipped with rip and cross-cut saw, band saw, boring and mortising machine, lathe, drill press, bolt cutter, pipe machine, emery wheel, grindstone, blower for forges, etc. An electric motor supplies the power.

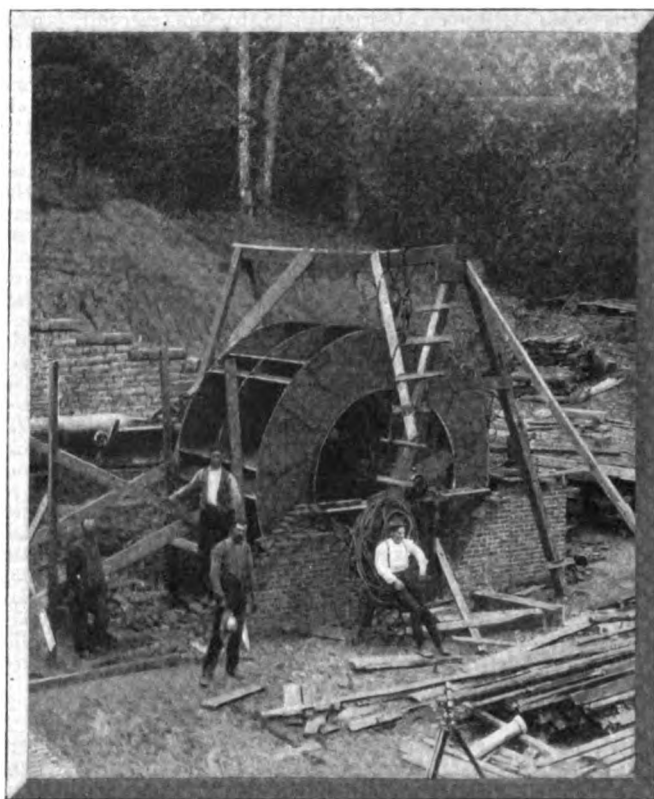
One of the first adjuncts to the development to be installed was a brick yard, with a capacity of 20,000 brick per day, and a steam dry house, so that brick were manufactured continuously through the winter. All the red brick required for oven fronts, mine arches, foundations and buildings for the Leckrone and Buffington plants were furnished by this brick yard, and a portion of the brick for the Footedale plant. Another brick yard was operated at Footedale worked during the summer, but without dry-house.

Among the buildings for which brick were furnished, were the boiler house, 48 ft. $\times$ 70 ft., power house, 48 ft. $\times$ 50 ft., machine shop, 48 ft. $\times$ 100 ft., office building, 40 ft. $\times$ 44 ft., two fan houses and the three store buildings of the Mount Pleasant Supply Co., each 40 ft. $\times$ 100 ft.

The roof trusses for these buildings are of steel and in general, wherever possible, steel construction is used.

Steam is carried from the boiler house 650 feet for the No. 1 fan engine and the brick machinery and dry house; also a line 1,200 feet long for heating the store and office, and for the engine for the ice plant at the store.

The Footedale plant is similar in all essential features to the Leckrone plant. The 400 beehive ovens are divided into two lines of 160 double block ovens and 80 bank ovens. There are two drift mines and a slope being driven to connect with the shaft at the



CAPELL FAN AT NO. 1 PLANT IN COURSE OF CONSTRUCTION.

Buffington plant. There is one hoist and a 1,000-ton bin at Footedale, all the coal from the three mines being brought to one point at the foot of the incline. In addition to the electric plant, an air compressor and hoisting engine are installed for the development of the slope. It is not the intention to take the supply for the ovens from the slope; but to provide, by means of the slope, an additional outlet from the shaft workings, and a traveling way for taking the stock to and from the mine, thus avoiding the use of stables at the shaft bottom.

The shafts at Buffington are 390 feet deep and are located within 500 feet of the property line, so that all the coal tributary to the shaft can be worked by haulage roads with grades in favor of the load. Four hundred ovens are in course of construction at this plant.

The power plant consists of six 150-horsepower tubular boilers; a compound two-stage air compressor, capacity 1,500 cubic feet of air per minute, compressed to 80 lb. pressure, furnished by the Nordberg Manufacturing Co., of Milwaukee, Wis.; one pair of 24" $\times$ 48" first-motion hoisting engines, furnished by the Vulcan Iron Works, Wilkes-Barre, Pa.; two self-dumping cages, furnished by Kenney & Co., Scottsdale, Pa.; a 1,000-ton bin erected by the Schultz Bridge & Iron Co., of Pittsburg, Pa.

There is also a 100-K. W. generator and engine for developing the power for the laries, electric lighting for the bottom of the shaft and tenement houses; and a Capell fan, 18 ft. $\times$ 10 ft. with a guaranteed capacity of 500,000 cubic feet of air per minute.

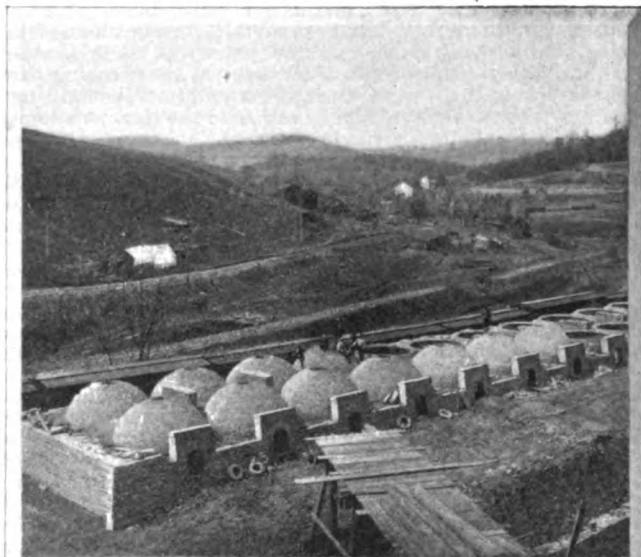
The main shaft is 24 ft. $\times$ 10 ft. 6 in., inside timbers, and the air shaft, 150 feet from it, is 17 ft. $\times$ 10 ft. The shafts were sunk by Captain J. H. Cundy, of the Iron Range ore region, of Michigan, and to his credit it can be said that there was not a single accident to life or limb during the sinking of these shafts.

At Leckrone, 94 double blocks and 21 single tenement houses have been erected, and several residences of a better class.

At Footedale, 90 double blocks, 20 single and three of the better class; and the same number at Buffington.

In addition to the three plants already constructed, a fourth plant, also of 400 ovens, is projected in the valley of Cat's Run, one-half mile east of Masontown.

Water is supplied to all of the plants by the Huron Water Co., which is owned jointly by the Federal Steel Co. and the American Steel & Wire Co. The pumping station is situated on the Monongahela River, at the mouth of Brown's Run. The pumping station is equipped with four 150-horsepower boilers, and two 3,000,000-gallon Wilson-Snyder Manufacturing Co.'s pumps (and foundations ready for a third pump), which force the water through a rising main 18 inches in diameter to a steel tank 60 feet diameter by 35 feet high, 500 feet above the river, a distance of 3,700 feet;



NO. 1 PLANT, COKE OVENS UNDER CONSTRUCTION, 250 IN BLOCK.
NO. 2 PLANT, COKE OVENS UNDER CONSTRUCTION, 150 IN BLOCK.

thence 3 miles by an 18-inch main to the reservoir, $\frac{1}{2}$ mile west of McClellandtown. The supply for the three plants of the American Coke Co. is taken off between the tank and reservoir. From the reservoir, a 10-inch line runs to the Leckrone Works, $2\frac{1}{2}$ miles, and a 10-inch line $2\frac{1}{2}$ miles to the Footedale Works, from which an 8-inch branch, $1\frac{1}{2}$ miles long runs to the Buffington Works.

This pumping plant has sufficient capacity to furnish water for all the works that will ever be built in what is known as the "Masontown District." The reservoir is located at a sufficient elevation to give 100 feet head at the Court House in Uniontown, ten miles distant. Each of the plants is provided with a sufficient number of tanks to provide a day's run for the ovens and boilers, while mains laid in the street give the high pressure for the house-water supply and fire hydrants.

The Masontown & New Salem Railroad, 12 miles in length, owned by the Federal Steel Company, connects the three plants of the Eureka Fuel Company. This road was constructed, and is operated by the Pennsylvania Railroad Company, under lease, connecting with their Coal Lick Run Branch of the South West Pennsylvania at Ache Junction, $7\frac{1}{2}$ miles from Uniontown. Leckrone is the terminus of the Smithfield & Masontown Branch of the Baltimore & Ohio R. R. Co.

Selwyn M. Taylor, mining engineer, of Pittsburg, Pa., designed and prepared plans for the work upon oven construction, power plants and mine development of the Eureka Fuel Company, the railroad location of the Masontown & New Salem Railroad Co., and the pumping plant and pipe lines of the Huron Water Co., having from three to five corps of engineers constantly in the field.

W. M. Judd, now chief resident engineer for the Eureka Fuel Company, was engaged with Mr. Taylor throughout the construction of the work.

[J. P. Brennen, general manager for the Eureka Fuel Company and Huron Water Company, and president of the Masontown & New Salem Railroad, superintended the entire construction of all of the plants, he having commenced the work June 1, 1899, after having made a report on the property.—EDITOR]

Disastrous Fire in Coal Mine No. 1, at Diamondville, Wyoming.

Written for MINES AND MINERALS, by Don Maguire.

On the night of Feb. 25, 1901, a disastrous fire broke out in Mine No. 1 at Diamondville, Wyoming, causing the death of 26 miners and doing much damage to the mine itself.

The management of the coal mines at Diamondville is very good and accidents of any kind have been few, but the nature of the coal is such that it ignites readily, and on the least contact with fire it is prone to break forth into conflagration. The origin of the fire is supposed to have been in the contact of the flame in a lamp with either the woodwork or canvas brattice along the passageways which spread to the coal and thus created the widespread disaster that followed.

The rapid spread of the flames prevented help reaching the unfortunate men from other quarters of the workings. Those who were near the outer workings of the seventh level and who managed to make their escape, seemed to have been so overcome by the excitement of the moment as to be unable to give direct and positive evidence as to what took place or as to the cause of the accident.

In all the mines of the Diamondville Coal Company there are employed about 400 men, and in the mine in which this fire took place there are employed, during the three shifts, about 200 men. The 7th level is about 2 miles in length.

Unfortunately, the men who were beyond the point where the fire broke out seemed to have lost all presence of mind and were unable, evidently, to reach an avenue of escape.

The men employed here are made up of Americans, Italians, Welsh, Hungarians, and Finns. Upon the first cry of fire the mine management on the ground at once set to doing all that lay in their power to allay excitement, and at the same time took steps to stay the progress of the fire. The men were quickly drawn from workings adjacent and contiguous to the locality of the fire, and had it not been that men were within the burning area that part of the works would have been shut off at once, thereby cutting off possibility of the fire spreading, but while there was any hope of saving life every effort was made to help the men. Water was turned into the burning area, but the fire continued to rage and no voice or cry came from the doomed men below, and as the most threatening aspect rested on the scene, it was decided best, at 9 p. m., to plug the mouth of the working.

The decision to do this destroyed the last ray of hope in the breasts of the poor creatures whose sons, husbands, or brothers were shut down far below in the seething prison of death. The wails and screams that broke forth as the work of shutting off the lower working by plugging of the adit began were simply heartrending; wives, mothers, sisters, brothers, and children

realized then that never again would they hear the voices of those who went forth as their bread winners a few hours before.

Such scenes are amongst the saddest that life affords, and once seen are never forgotten.

When the entry into the burning district was plugged, and the terrible excitement was in a small way allayed, those laboring to control the difficulties and misery of the occasion began to realize and understand the nature of the fire.

It was then learned that the fire began at 4:15 in the afternoon and that it began between rooms 40 and 46 in the sixth south entry. This entry is situated about 5,000 feet from the main incline. Almost 3,000 feet from the main incline or slope there is a side track, and at this point drivers gather their loaded cars, and trips are made up to be taken to the slope by the outside drivers who haul the trip with a spike team. Here the drivers make use of a piece of brattice, or heavy duck, which serves as a screen to break the strong air current, and it is believed that this brattice cloth took fire from a driver's lamp. As there was near the brattice a quantity of dry boards and timber it was but a moment until a fierce fire was burning, which set fire to the coal faces adjoining, the flames, gas, and smoke being carried downward to where the miners in that part of the mine were employed, shutting them off from all possibility of escape after the fire had gotten under way. Moreover, these men were Hungarians, Finns, and Italians and could not speak English, and when called upon to escape they did not seem to understand the orders given them. A Mr. Charles Mahon ran forward amongst these men, upon first realizing that there was a fire raging in the mine, and warned them to flee for their lives; Mr. Mahon escaped by a back entry, and had the unfortunate men followed him, all would have been well, but they seemed dazed, and as the dense clouds of smoke rolled in upon them they doubtless soon became bewildered and suffocation followed. Every possible effort was made to reach them, but with the only result that many of the rescuing party came near losing their own lives in the attempt. When at length it was seen that all attempts were in vain, and that further attempts were only endangering life and property, the entries were plugged and the fire confined within a given area.

Mr. Sneddon who is manager of these mines, had months ago prepared the entries for emergencies of this kind and when the work of shutting off the burning district began it was only a short space of time until all other parts of the mine were safe from spread of the fire. After 24 hours had passed, efforts were renewed to reach the suffocated miners and the search continued night and day until March 3d, when the first few were reached where they had fallen. It was then found that the fire had not reached that part of the mine, and that death resulted from suffocation. These first victims having been thus reached, work of rescuing the bodies continued, and at a little after midnight on the morning of March 4th the remaining 18 bodies were reached in the areas where they had been overtaken by the gas and smoke. They were all found within the main area of the 6th level, within easy speaking distance of each other. It would seem that the men died peacefully, some with their arms folded, others as though they had laid themselves down to sleep. The bodies, although within the depths for 8 days, were in an excellent state of preservation.

Sodium Amalgam.

Wm. Crookes, the inventor of the alloy sodium amalgam, gives the following detailed directions as to its preparation. The mixture of sodium and mercury is in the proportion of three parts of sodium to ninety-seven parts of mercury. "Place a strong iron flask with a narrow neck nearly up to the mouth in sand on a sand bath kept at a temperature of about 300° F., weigh out the mercury and sodium, and put the former into the flask, and then add the sodium in pieces as large as a pea at a time, waiting for the action to cease before adding a fresh lump. The sodium had better be dropped in with a pair of tongs, and the hand should have a cloth over it. At each addition of the sodium a slight explosion is heard and a bright flame will issue from the mouth of the flask. The action gets less violent as the mercury becomes richer in sodium. When the whole of the sodium has been added, pour the amalgam into a flat dish while still liquid, and when cold break it up and preserve in a stoppered jar. It will not require to be kept under naphtha. The amalgam forms a mass of long, needle-shaped, brilliantly metallic crystals, which interlace in every direction, but have very little cohesion." The inventor recommends the use of the amalgam in coarse powder. By sprinkling it over the wetted surface to be amalgamated, then rubbing it over with a little clean mercury, a firmly adherent and brilliant coating of mercury will be given to the metal. The use of sodium amalgam has a tendency to keep the mercury bright and active, but it cannot be expected to perform any other part in the extraction of gold than in aiding amalgamation.

ELECTRIC MINE LOCOMOTIVES.

Things to be Observed in the Choosing, Operating and Caring for Mine Locomotives to Ensure the Greatest Economy.

Written for MINES AND MINERALS, by W. B. Clarke.

The electric mine locomotive has been an important factor in the economics of mine operation, and its inherent advantages have been demonstrated by years of successful service. The compressed air mine locomotive has its field of usefulness, to be sure, but under ordinary conditions the electric locomotive possesses many points of superiority. The steam mine locomotive will never be extensively used for obvious reasons, and mine operators are beginning to appreciate the inefficiency of the various rope haulage systems, although it must be admitted that where the grades are very severe and of considerable length, some form of rope haulage is superior to the traction system.

The first electric mine locomotive was built in 1887 for the Lykens Valley Colliery of the Pennsylvania Railroad Company, and since that time very rapid progress has been made until the modern mine locomotive bears very little resemblance to Schlesinger's aptly named "Pioneer." Some idea of the extent to which electric mine locomotives are used may be gained from the fact that in the State of Pennsylvania there are more than 250 in daily operation.

It is the purpose of the writer to call to the attention of mine owners a few facts in connection with the care and operation of electric mine locomotives. In the first place, the importance of a correct relationship between the weight of the locomotive and the capacity of its motors, should be thoroughly understood. The weight of the locomotive determines the maximum tractive effort, a point beyond which the wheels will slip, while the service, broadly speaking, which a locomotive will render depends upon the capacities of the motors. Various tests seem to show that the maximum tractive effort of a locomotive under ordinary conditions is 20% of the weight on its drivers, which should be such that the wheels will slip before the motors become dangerously overloaded. To use a steam engineering expression, the electric locomotive should be "over-cylindrical," since the motors of an over-loaded electric locomotive will not stop like an under-cylindrical steam or compressed air locomotive under the same circumstances, but will persevere until the wheels slip, or their windings burn out.

The passage of an electric current through a conductor generates heat, the amount depending for a given current, upon the resistance opposing its flow, or with a constant resistance, upon the square of the volume of the current. The capacity of an electric motor is determined, therefore, by the current which it will carry in its windings without dangerous over-heating and consequent injury to the insulation. A motor with a nominal capacity of 50 H. P., as rated for street railway or mining service, will develop 50 mechanical H. P. continuously for one (1) hour, with a rise in temperature of the windings not exceeding 75 degrees Centigrade. If the same motor were operated at a steady load for a period of eight (8) hours, for instance, the load would have to be reduced to about 12 H. P. in order to keep the temperature within a safe limit. If a locomotive, therefore, were operated continuously the load on the motors would have to be reduced below their nominal rating in order that the temperature might not become too high. On the other hand, if the service were very intermittent, the motors might be operated at loads considerably in excess of their nominal rating for short periods of time. Since the service required of an electric mine locomotive is of an extremely intermittent nature, it is obviously of the utmost importance that the motors possess a large momentary capacity; i. e., that they be capable of rapidly radiating the heat generated in their windings. Experience has shown that under ordinary conditions mine locomotives rarely work continuously at their maximum loads for periods exceeding 15 or 20 minutes and we

may, therefore, determine the maximum capacity of a locomotive as the load which it will propel for twenty (20) minutes, the rise in temperature in the motor windings during that time not to exceed a safe limit. Having established the maximum safe load for the motors, we must so adjust the weight on the drivers that beyond this maximum safe load, the wheels will slip. This is a point which should be clearly understood and given careful consideration in the purchase of mine locomotives. The general operating conditions should also be considered, especially the degree of the intermittency of the service. If the periods of maximum loads are very frequent, a larger locomotive should be chosen than if there are longer intervals during which the motors may radiate their heat and become cool. A larger mine locomotive would be required to haul a given load on a long level track than to haul the same load on a short track, even with occasional adverse grades. In the former case the load would be more constant, with few opportunities for the motors to cool, while in the latter case the periods of cooling would be more frequent.

The folly of operating electric mine locomotives at the slipping point of their wheels should be clearly understood, since the adhesion of slipping wheels (or "skidded" wheels, for that matter) is very small indeed. For instance, a locomotive might be hauling a certain load at a speed of six (6) miles per hour, and exerting a draw bar pull of five thousand (5,000) pounds. If an attempt were made to accelerate the speed too rapidly to nine (9) miles per hour, the tractive effort would rapidly increase until the wheels began to slip, when the draw bar pull would diminish and

the train would be retarded instead of being accelerated. The slipping of the wheels relieves the motors, to be sure, and is a feature of proper locomotive design, but energy is worse than wasted in sliding friction which wears out the wheels and rails. Considering the extreme hardness of the rims of the chilled iron wheels, and the deep grooves often worn in them, it is evident that the amount of wasted energy is by no means insignificant. The rapid wearing of the wheels is also due to the too copious use of sand, a useful expedient, but one which should be adopted as seldom as possible. It is a much better practice to lay heavy rails, especially in the main entries where the service is the most frequent, and the heavier the rails the less sand will it be necessary to use. Furthermore, the maintenance and depreciation of a haulage system laid with heavy rails are much less than with light rails, and the general operation much more satisfactory. The

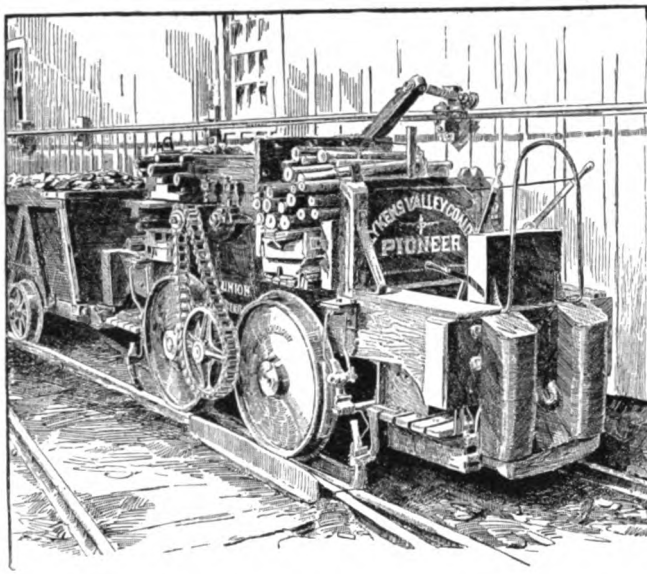


FIG. 1. ONE OF THE EARLIEST ELECTRIC LOCOMOTIVES.

accepted formula for determining the weight of the rails assigns ten pounds per yard for each ton of locomotive weight per driving wheel. For the relatively small locomotives used in the mines, however, a constant of two (2) should be applied to this formula. In other words, a ten (10) ton mine locomotive should operate on 50 lb. rails, rather than on 25 lb. rails. With the advent of the pressed-steel coal car many railroads have been obliged to relay their tracks with heavier rails, thereby offering excellent opportunities to the mine owner to purchase 50 and 60 pound rails at very low figures.

The remedy for the too rapid wearing of the wheels lies largely in the hands of the motor-man, assuming that the locomotive is equipped with proper controlling apparatus. A heavy train of ore or coal cars should always be started "slack," i. e., before starting ahead the cars should be pushed together. Since the tractive effort is sacrificed by the slippage of the wheels, the starting of a locomotive should be gradual, and too rapid acceleration should not be attempted. In order to successfully start a heavy train a locomotive should be equipped with a controller of the magnetic blow-out rheostatic type, and the motors should be connected in multiple, as shown in Fig. 3. For this class of service it is not feasible to use the ordinary series parallel controller, which has been so successful in street railway practice, where the entire load is on the drivers. On an electric locomotive, the motors should be independent of each other when starting and resistances or rheostats of ample capacity should be provided, so arranged that the controller may be operated on the starting

notches for considerable periods of time. Such a controller in the hands of an intelligent motor-man will enable him to start a heavy train with a minimum demand upon the generator. On the other hand, if the controller is not properly designed, or if the motor-man is inexperienced or careless, the results will be of a very opposite and unsatisfactory nature. If the controller is manipulated with sufficient rapidity, a locomotive with no load except its own weight, may be made to stand practically still and spin its wheels on the track, and the faster the wheels spin, the less their tractive effort, or tendency to propel the locomotive. This fact emphasizes the importance of approaching the other extreme, and of "making haste slowly," especially when starting a heavy train. At this point it is well to emphasize the importance of employing experienced and reliable motormen. Each motorman should have a careful training, and should understand the machine in his charge. An ammeter, which indicates the instantaneous consumption of power, should occasionally be placed on the locomotive, so that the motorman may learn to manipulate his controller in such a manner as to accomplish the desired results with minimum current. Economy apparently amounts to very little in a coal mine where fuel charges are low, but the careful and economical use of the current ameliorates the service of the generators and motors, thereby reducing the maintenance account and enables the operation of more electrical machinery from a generator of given capacity, thus reducing the investment charges.

The speed of an electric mine locomotive depends largely upon the load, decreasing as the load or draw bar pull is increased. Conversely, a reduction of the load causes an increase in the speed and a locomotive whose speed at its rated draw-bar pull is eight (8) miles per hour would run at eighteen (18) or twenty (20) miles per hour at no load, unless the speed were reduced by inserting

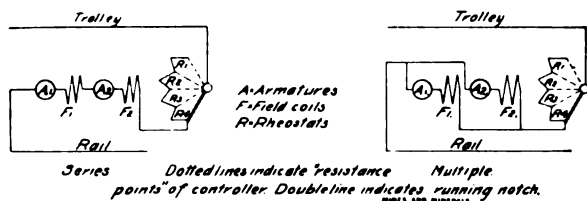


FIG. 2.

FIG. 3.

resistances in the motor circuits, thereby reducing the voltage across the motors. It is usually necessary to operate on resistance when running in with the "empties," or switching, as derailment of the cars is liable to occur unless the speed is kept within certain limits, depending upon the condition of the cars and track. Under these circumstances it is desirable to operate the motors in series, (See Fig. 2), in order to economize the current and reduce to a minimum the amount of energy dissipated in heating the resistances. Such a practice will materially increase the life of the resistances and obviate the annoyance of their all too frequent renewal. A special mine locomotive controller of the well known magnetic blow-out type has recently been designed, and is so arranged that the motors may be operated in series or multiple, as the occasion may require. When starting or hauling a heavy load, the motors should always be connected in multiple, but when starting a light load, or when running in with the "empties" the motors may be operated in series. This controller is an important advance in mine locomotive engineering and its value cannot be over-estimated. The motorman should be instructed to use as much as possible the "running notch" of the controller; i. e., the last point, with no resistance in circuit, operating on the intermediate points freely only when starting.

Annoying delays are often experienced at mine haulage plants, where there are several locomotives, due to the frequent

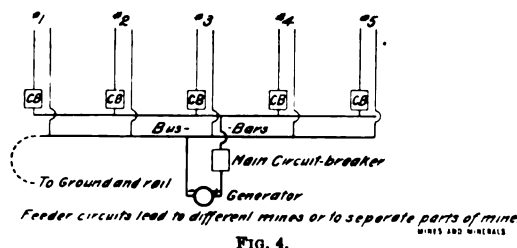


FIG. 4.

"blowing" of the circuit breakers. It is proper, of course, that the circuits should be automatically opened, when the generator is called upon to deliver a current beyond its safe capacity, but it is annoying if the service is interrupted with too great frequency. The remedy for this trouble also lies, to a very great extent, in the hands of the motorman, as the intelligent use of the con-

troller will minimize the demand upon the generator. This trouble is aggravated by the simultaneous starting of all of the locomotives when the circuit breaker is reset by the engineer at the power house, since each locomotive requires a comparatively large current when starting, and the sum of their starting currents is often sufficient to immediately blow the circuit breaker

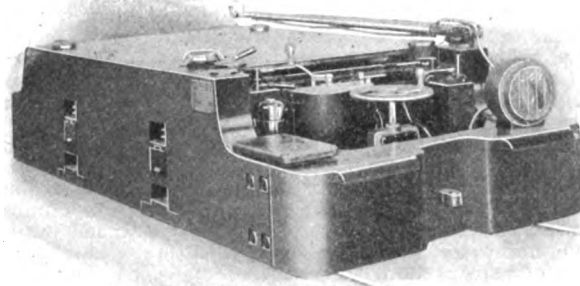


FIG. 5.—ONE OF THE LATEST TYPES OF ELECTRIC LOCOMOTIVES.

again. In this way it often happens that the circuit breaker is thrown out several times in rapid succession, and the entire haulage system may be interrupted for a half hour or more. The engineer occasionally becomes righteously indignant, allows the circuit breaker to remain out a few moments before resetting it; and the relations between the employees of the power house and the motormen become strained, with no good results to the company.

As a remedy for this trouble, the following suggestions may be offered:

First.—Each locomotive should be equipped with an individual circuit breaker, so set that it will open when the safe current of the motors is exceeded, i. e., at just about the slipping point of the wheels. The circuit breaker should be installed in such a manner that it cannot be held in by the motorman and should be of such design that it cannot be tampered with or "plugged."

Second.—Each motorman should be given a serial number, and whenever the circuit breaker has been reset at the power

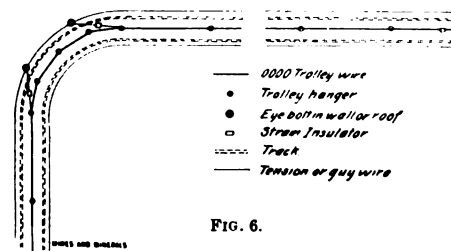


FIG. 6.

house, they should start their locomotives in succession. Motorman No. 1, for instance, should start as soon as the power is turned on, as indicated by illumination of the headlights on his locomotive; No. 2 should follow in, say fifteen (15) seconds; No. 3 in thirty (30) seconds, and so on, until the entire plant is again in operation. This system may seem elaborate, but the motormen quickly appreciate its value, and even the last man will prefer to wait two or three minutes rather than suffer a much greater delay, due to repeated interruption of the supply of power.

Third.—Each feeder should have a separate circuit breaker, so that an unusual demand for current, or a "short circuit," due to a "fall of the roof," for instance, may be localized and the interruption confined to the circuit on which the trouble has occurred. This suggestion is made plain by the diagram in Fig. 4.

The maintenance account, one of the principal criteria of good management, is a necessary evil, and eternal watchfulness is the only means by which it may be reduced to its minimum. The smallest street railway systems almost always have a system of rigid inspection, and every night each car is thoroughly cleaned and carefully examined. Mine locomotive service is even more severe than ordinary street railway work, and the proper care of the apparatus is of correspondingly greater importance. At night each locomotive should be run over a pit and should be carefully inspected and cleaned for the next day's work; while an extra

thorough cleaning should be given the entire locomotive at least once a month. In this way loose nuts and bolts, worn out gears, thin bearing linings, and a number of other minor defects would be discovered and remedied before they became the source of more serious trouble. A spare armature or two should be always carried in stock, and each of the armatures should be regularly replaced, and then thoroughly cleaned and repaired and given a coat of insulating paint. The work of inspection should devolve upon a careful and painstaking man of some mechanical ability, and if there are many locomotives, he, with his assistants, should be employed as an all-night force. The inspector should also be required to make a daily report on suitable blanks, covering the

a turn-buckle in the tension wire. A grooved trolley wire with suitable hangers recently placed upon the market by a prominent electrical manufacturer seems to be especially suitable for this class of work and permits of very rapid and inexpensive trolley line construction. It is very desirable to use as heavy trolley wire as possible, since the larger wire has greater current carrying capacity and possesses a very desirable rigidity conducive to sparkless running of the trolley wheel. In a 500 volt plant the writer would recommend the use of 0000 grooved trolley wire which, in connection with a well bonded track, would seldom require the installation of separate feed wires. In this connection it is well to state that to obtain the same results the copper varies inversely as the square of the voltage, i. e., a 250 volt plant requires four times as much copper as a 500 volt system.

The importance of using conductors of large capacity is easily demonstrated: Suppose a locomotive to be operating on a grade 1,000 feet in length and 10,000 feet from the power house and that the current consumed is 300 amperes. Assuming the generator voltage to be 500, the line loss with insufficient copper would amount to at least 250 leaving but 300 for the motors and the speed would be about four miles per hour. If the feeder and trolley wires were of proper size the line loss would not exceed 100 volts, the voltage across the motors would be 450 and the speed would be about 6 miles per hour. In the former case the service of the generator and locomotive would be 50% more severe since the duration of the 300 ampere load would be three minutes while in the latter case the grade would be ascended in two minutes.

SUMMARY.

Summarizing, the following suggestions may be offered:

First.—Purchase locomotives of reliable manufacturers, who can offer motors which are the result of their experience in street railway work, where analogous conditions exist.

Second.—Purchase locomotives of ample capacity and do not attempt to operate them at continual overloads.

Third.—Be sure that the controlling apparatus is of proper design and so arranged that the locomotive may be started slowly and operated at, at least, two (2) speeds, with no resistance in circuit.

Fourth.—Equip each locomotive and feeder circuit with an individual circuit breaker.

Fifth.—Lay heavy rails especially in the main entries, and use as little sand as possible.

Sixth.—Employ intelligent and reliable motormen and pay them sufficiently high wages to make it an inducement for them to interest themselves in their work.

Seventh.—Last and most important, establish a rigid system of inspection and carry a liberal stock of repair parts.

Coal Creek, Tennessee.

Mr. E. C. Camp, President and General Manager of the Coal Creek Coal Company briefly describes these mines as follows:

We operate two mines at a station on the K. & O., a branch of the Southern Railway, 30 miles from the city of Knoxville, Tennessee. We have some 800 acres of coal yet untouched in one body and right in the heart of the Cumberland Mountains. The seam ranges from four to six feet in thickness and lies nearly level at a height of about 40 feet above valley land where railroad tracks are, thus giving good chute facilities.

The coal is semi-bituminous and has been successful in every test for thirty years made for either steam, gas or domestic purposes and these tests have included Pittsburgh coal, Pocahontas coal of Virginia, the Alabama, other Tennessee, and Kentucky coals. At our Fraterville mine we use haulage rope in pulling loaded cars out and empties in. The distance in the mine is two miles.

At Thistle mine we are still hauling with mules entirely. Top and bottom are hard slate with scarcely any seam of rash or dirt for miners' picks to easily penetrate. We are just erecting one fan, ventilating shafts have been used and ventilation has been ample. Mines adjoin and are opened into each other while the lands below being worked out our water is drained through them for a mile or more. Our coal goes all over the Southern States, and the Southern Railway itself uses very largely of our output which is some 50 cars of 27 tons average daily. The demand for our coal is much greater than the facilities for transportation will permit us to supply and has so been for years, the demand outgrowing the capacity of cars and engines to pull.

West Virginia Central and Pittsburg Railway Co.

MINING DEPARTMENT (Thomas Plant).

REPORT OF CONDITION OF MOTOR

19)

Motor No. _____ was carefully inspected by me this P. M. and found

to be in need of the following Repairs, viz.:—

Motorman.

NOTE:—If no Repairs are needed, return this Blank so marked.

Motormen must carefully inspect their motors after each day's run, and report their condition on this form. They will be held responsible for every defect not reported. No attention will be given to verbal reports or reports not signed by Motorman.

condition of each locomotive. This may seem to be an unnecessary refinement, but it interests the inspector in his work, places before the management the result of his labors and constitutes a powerful incentive to faithful service. The inspectors will soon become expert and learn just where to look for trouble, the maintenance account will be surprisingly reduced, and the efficiency of the entire haulage system markedly increased. Under this system the all too frequent interruptions of service will be almost unknown and only when a most serious break down occurs will the use of a locomotive be lost for a day. The efficiency of the inspection system, the importance of which cannot be overestimated, may be greatly increased by carrying in stock in the repair shop at the mines, a liberal supply of those parts of the locomotive which experience has shown to be subject to repair or renewal. The stock need not be large, but it should be maintained by placing frequent orders. It occasionally happens, where no inspection has been adopted that a bearing lining, for instance, becomes badly worn out and finally breaks. The locomotive then has to be "laid up" for repairs and, since it is not usually the policy of the mine to carry supplies in stock, it is necessary to send to the manufacturer for a new lining. If the locomotive is of recent manufacture, prompt shipment may be expected, but if of an older type, a delay of several days, perhaps weeks, is liable to occur. The electric mine locomotive has been developed within the last few years, and the present modern type shown in Fig. 5 is the result of a process of evolution, a series of changes and improvements in design and construction. These features of the older types of locomotives, which constitute the supply parts, become obsolete at the factory, and for that reason an unexpectedly long time is required to fill the orders. The delay and expense due to the loss of the use of the locomotive, the consequent reduction of the output, the express and telegram charges, not to mention the annoyance, can be avoided, if

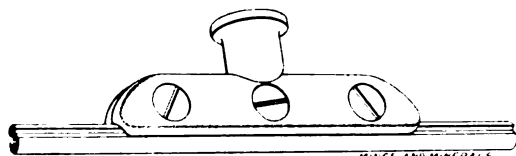


FIG. 7. TROLLEY WIRE HANGER.

the locomotive is regularly inspected and if extra parts are carried in stock at the mine. Blank form of inspector's report is show above.

The trolley construction should be of the most substantial nature and great care should be exercised in the original installation. The hangers should be securely fastened in place at intervals of from 25 feet on straight lines to 10 feet on sharp curves. The wire should be as taut as possible but the strain should be removed from the hangers at the ends of the lines and on each side of the curves and carried by guy or tension wires as shown in Fig. 6. One end of the tension wire should be fastened to the trolley and the other end through a suitable strain insulator to an eye bolt in the wall or roof. It is very often convenient to place

WATER-SOFTENING PLANT

At Langwith Colliery—A Description of the Process and Apparatus by Which Very Hard Water Was Purified.

By J. G. Shearer.*

It is not at every colliery that a supply of good water for boilers can be obtained, and where the quality is bad, it is desirable to adopt some method of treatment to deal with and neutralize the evil effects to the boilers caused by such water.

At Langwith colliery, near Mansfield, belonging to the Sheep-bridge Coal and Iron Company, Limited, the water has 28 degrees of hardness (14.6 degrees being temporary and 13.4 degrees permanent), the solid matter weighing 29.2 grains per gallon. Previous to the introduction of the water-softening process, the scale formed in the boilers was of such a hard and flint-like character that it could not be chipped off the plates. The Galloway cross-tubes were nearly filled solid with deposit, so that a bar of iron 1 inch in diameter could not be pushed through some of them. The scale on the sides of the shells of the boilers and on the flue-tubes was in places $1\frac{1}{2}$ inches thick, and the internal feed-pipes had to be taken off and the scale burned out of them every fourth or fifth week. The rivetted seams of the shells were constantly leaking, and it was of frequent occurrence that a Galloway tube had to be taken out and replaced, owing to fracture.

In 1897, a Howatson process water-softening plant was erected capable of dealing with 8,000 gallons of hard water per hour. The process reduces the hardness from 28 degrees to 8 degrees. The effect on the boilers is very marked: there is very little new scale forming, and the old scale is gradually breaking off in flakes. The newly deposited scale shells off, when about $\frac{1}{4}$ inch thick, in patches about 1 foot square; and it is found, by cutting grooves in the old thick scale down to the boiler-plate, that an action is set up by the softened water which lifts off the scale in patches in from 2 to 3 months.

Instead of the impurities in the softened water forming on the plates, they are thrown down in the form of mud or sludge and blown out through the blow-off cocks. In a new boiler, 8 feet in diameter and 30 feet long, recently fixed, the quantity of sludge left in the boiler after working 4 weeks weighed 148 pounds, when dry. The tubes and shell were swept and no scale was found, and the plates were white as if lime-washed.

The plant, Figs. 1 and 2, comprises a chemical or top-tank A, with a capacity of 6,000 gallons, which is filled with water, and a charge consisting of 30 pounds of soda-ash (58 per cent. of alkali) and 80 pounds of Buxton lime. This is well mixed mechanically for 10 minutes and then allowed to settle for about $2\frac{1}{2}$ hours. Whilst the water in A is settling, that in the other top-tank B is being run off. When the water in the tank A is ready, the outlet-valve b is closed and the outlet-valve c is opened. The chemically-treated water then runs into the small tanks a, a. At the same time, the hard water is flowing into the small tanks, a₁, a₁, and mixing with the softened water in the small tanks, a₁, a₁. The respective quantities are regulated by float-valves, and by the orifices from the tanks a, a, and a₁, a₁, being proportioned to give the required flow from each. From the tanks a₁, a₁, the now softened water flows into the two filtering or bottom-tanks, C, C. These tanks have a partition in them from the top to within 2 feet of the bottom. The water passes down the side of the partition nearest the small tanks, a, and rises on the other side through a filter-bed, 2 feet thick, composed of wood-shavings between galvanized-iron netting, with a mesh about $\frac{1}{2}$ inch square. The water is then pumped by a pump to a storage-tank on the top of the engine-house,

whence it is distributed to the boilers, in two ranges, and to the workmen's cottages.

It will be seen that only one top or chemical tank, A or B, is used at a time, and that both of the bottom or filtering-tanks C, C, are continually at work. Four charges of chemicals are inserted per day, a charge every 3 hours, and the total quantity of water softened is 10,000 gallons per hour, of which 2,000 gallons passes through the chemical tanks A and B, and 8,000 gallons passes through the hard-water tanks, a₁, a₁.

All the tanks are thoroughly cleaned once in 14 days. The spent-time is used for making mortar.

A certain amount of trouble is caused by imperfect filtration. The water after being filtered holds in suspension a quantity of lime-particles, which, settling in the pipes and connections, must be cleared out periodically. The effect is not so bad or so detrimental in the cold-water pipes as in the hot-water feed-pipes, donkey-pump and connections to boilers. The latter must be cleared out every 4 to 6 weeks. The deposit chiefly consists of lime, and is quite soft. In a 12-inch pipe, connecting two feed-water heaters, the thickness of the deposit around the pipe was 4 inches. This pipe had not been cleared for about 4 or 5 months, and in pipes leading from the feed-water heaters to the donkey-pump, 4-inch bore, the thickness of deposit attained $\frac{1}{2}$ -inch to $\frac{3}{4}$ -inch in 5 or 6 weeks. It may be noted that the

hotter the exhaust steam (or the greater the volume) coming into contact with the water, the greater is the amount of deposit.

Although the water after passing through the filter appears quite clear, or may have a slightly cloudy appearance, yet on coming into contact with heat the minute particles of lime unite, in the form of flat flakes, which do not settle so long as there is the slightest movement in the water, and it is this lime which fills up the pipes. It is also seen in the packings of the steam-cylinders, especially at the valve-spindles of the winding-engine. The valve-covers are sometimes quite white with lime.

To overcome these difficulties it is proposed to heat the water in the chemical and filtering tanks by means of hot water from the condenser attached to the hauling-engine. A quantity of water will be run into one of the filtering tanks; and, then, the contents of the chemical tank, after being heated and charged with chemicals, will be run into the bottom tank to make up $1\frac{1}{2}$ hours' water-supply. This water will be allowed to stand for $1\frac{1}{2}$ hours, and then it will be pumped to the feed-water heaters, where it will again come in contact with the hot

exhaust-steam, and will also have time to settle, according to the volume of the feed-water heater. By this means it is hoped that very little deposit will be made either in the pump or in the connections to the boilers.

The plant has been working for about $2\frac{1}{2}$ years, and is giving satisfaction. The softened water is used by the cottage-tenants, and is much preferred for household purposes.

One man attends to the water-softening plant, which occupies 4 to 5 hours per day, and works, with the cleaning-out of tanks, $13\frac{1}{2}$ to 14 shifts per month. The cost of softening 1,000 gallons of water, including chemicals and labor, is 0.8 penny.

Rankine in his "Steam Engine" bases his calculations of results with forced draft on an air supply of only 18 pounds of air per pound of coal, while those upon chimney draft are based upon 24 pounds, and then remarks that "with a forced draft there is less air required for dilution, consequently a higher temperature of the fire, consequently a better economy of heat than there is with a chimney draft." So also D. K. Clark in his work on the same subject states that "the system of forced draft opens the way for increase of efficiency in facilitating the adoption of grates of diminished area in combination with acceleration of combustion."

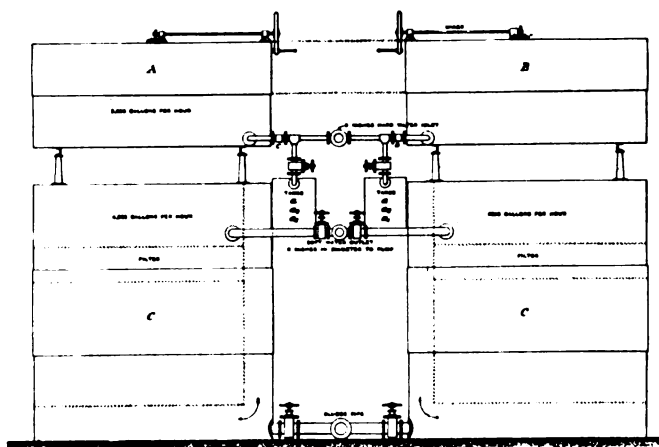


FIG. 1—SIDE ELEVATION

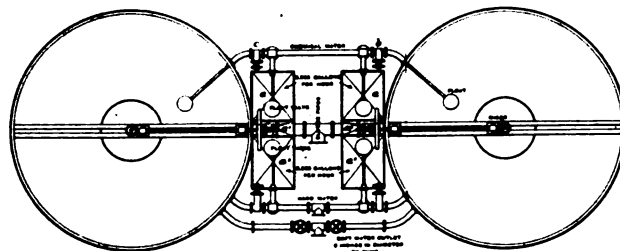


FIG. 2—PLAN

* A paper read before The Institution of Mining Engineers, England.

PROSPECTING IN CHINA.

A Description of the Country North of Peking—A Peculiar Country and a Peculiar People.

Written for MINES AND MINERALS, by Auguste Mathes.

Our party consisting of myself and two assistants, Messrs. Ireland and Field, left Denver in February, 1900, to examine some mining concessions in northern China for a New York syndicate.

We sailed from Vancouver, on the Steamship Empress of China to Shanghai, thence on a small steamer up the Yellow Sea to Taku; from Taku we went by rail through Tien-Tsin to Peking.

Our trip from Denver to Peking occupied just about a month's time and brought us there in the latter part of March.

Within a few weeks of our arrival in Shanghai the ice in the Yellow Sea had broken and navigation had opened for the season from Shanghai north, several steamers having preceded us to Taku.

It is optional with the visitor to China whether or not he shall see China before he reaches Peking, but there his option ends. The architecture of the portion of Shanghai in which the traveler lands is modern European, embracing large rectangular buildings several stories high abounding in columns; the streets are clean and the atmosphere pure; the same is so of the City of Tien-Tsin. It is true that in both cities one rubs against citizens of all countries under the sun, and more especially is this so in Shanghai, where on the Bund along the water front, not only nearly all the race types are visible but every device of conveyance is there, from jinrikishas to wheel barrows, Sedan chairs, modern carriages, donkeys and bicycles, but China, the real thing with its sunless alleys, foul smells, squalor and filth and unrelieved disciples of Confucius, is away from the modern portions of these cities and may or need not be visited, but when one passes through the gates of the outer wall of Peking, he is of necessity amongst the Chinese and their ways.

The Imperial railway ends within five miles of Peking; an electric tramway system connects the terminus of the railroad with an outer gate of the Imperial City, where the jinrikisha is strongly in evidence and carries one in half an hour and for the small consideration of ten Mexican cents as a minimum to whatever one through Chinese eloquence is made to pay as a maximum, to the only foreign hotel in Peking, the Hotel de Peking.

The main street from the outer gate of the city to the wall of the Tartar City is straight, a mile long or more and about fifty feet wide, with a flagged side walk in the middle. It is a bedlam of sound and a kaleidoscope of sights, with wares and their vendors on each side of the walk seemingly hopelessly, but really safely mixed with vehicles and the hoofs of horses and camels.

We were delayed in Peking two weeks through Chinese red tape in the preparation of our passports, which by the way we were never required to show. While there making our preparations too, for the trip north, vague rumors came several times from Tien-Tsin of a contemplated Boxer uprising, but we were of the majority of unbelievers in the consummation of that movement and calmly went on with our preparation. We were wisely advised by our minister Mr. Conger not to take an escort of Chinese soldiers, who surely would have been in the way and might have been dangerous, so we only added to our party an interpreter, Mr. Edward Lowry, whose wife's diary of the siege of

Peking appeared in the November number of McClure's Magazine, and some Chinese servants.

There were many things to carry on our trip besides our surveying and chemical apparatus, for Chinese food is undesirable and their drinking water impossible, except when boiled with coffee and tea. The sewage of a populous country finds its way to the rivers and streams and the dead are buried above ground; to misquote Edwin Arnold "the dead are many and the living are not few." So the water from the streams is impure and the water from the shallow wells, which are in frequent use in the cities and surrounding country is worse. During our stay at the hotels of Shanghai, Tien-Tsin and Peking we only saw plain water drunk at table once and that was by a Japanese at breakfast in Tien-Tsin. The usual beverages are mineral water, ales and wines. We were fortunately able to provide ourselves with American canned goods, bacons, hams, and Apollinaris water in Peking.

The Chinese cart is a combination of Roman chariot and emigrant wagon, the lower part chariot, the upper part emigrant wagon.

It required twelve of these carts to carry our stuff. Each cart was provided with two animals driven tandem without other reins than a single cord attached to the foremost beast, which cord by the way was seldom used, as the guiding was done almost entirely by speech, to which the animals responded perfectly.

We were not surprised to see them start when the driver uttered a sound like "whoa," for it substantiated the traditional attitude of the Chinese toward our institutions.

For our own use we purchased riding horses, which were small, but like the western mustang of our country possessed of much endurance. We also purchased a couple of mules which were not successes. One was strongly recommended by a missionary doctor who was educated in the United States. It was our intention to have returned him a copy of David Harum with his mule, but in the Boxer hostilities which followed, this was forgotten.

The measure of values used in Peking and the country north of it, is the Kung-fa tael, a fluctuating measure, for which there is no corresponding coin. While we were there its average value was seventy-two cents gold. In Peking, Mexican and Chinese dollars

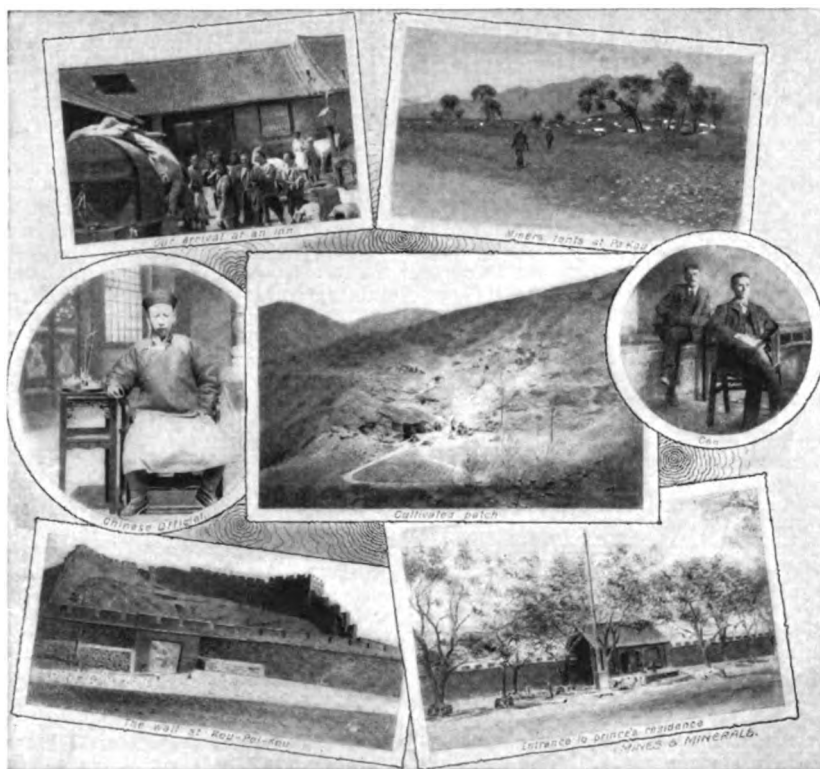
were in use and also Imperial Railroad bills, but in the country north they were not current; there chunks of silver passed in weights of Kung-fa taels. We therefore provided ourselves from the Peking Bank with pieces of silver in the shape of domes, an inch or little more high and from an inch to two inches in diameter at the base, weighing from ten to twenty ounces each. This necessitated taking along our comrade who traveled with a scales, the pan of which was suspended by a string to a graduated beam. After having chopped off with a hatchet enough small pieces of silver from a dome, he would weigh them, then making up the exact amount with copper cash pieces, twenty of which generally make a cent, would pay our bills.

The copper cash he kept strung on a wire hoop a foot in diameter. Silver of which we carried with us a thousand taels was locked up in a wooden box in the comrade's care.

Our party left Peking on the 14th of April taking a northeasterly course and reaching the town of Kou-peï-kou situated at one of the passes through the Great Wall of China, after three days' travel.

THE WALL AT KOU-PEI-KOU.

The altitude of Peking is 120 feet above sea level. Going northeast from there over a level plain or steppe, in a couple of

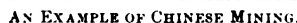


VIEWS IN CHINA.

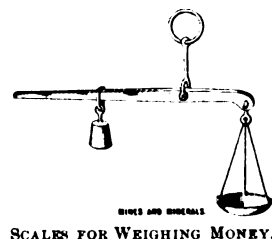
Our first examination was of a concession in the district of Chai-lirh, situated about a hundred miles north of Peking. The veins there are mostly white quartz, carrying values in gold, silver and copper; in one case only of those visited the vein filling is felsitic. The deepest mine in the district was 120 feet deep and by the methods employed cannot be sunk any deeper on account of water flowing from the vein. The most primitive methods of mining are employed being a little lower in the scale than those which were formerly practiced by the Spaniards in Mexico. In all the workings of the latter which I have seen in Mexico, shafts have

Nevertheless with these crude methods of mining and metallurgical methods still cruder, the Chinese work a number of mines in the district profitably. We examined a dozen properties there all under a hundred feet in depth, with the gold free at the surface but running into sulphurets at a short distance below. In the 120 feet deep property the ore was a chalcopryite and in the deepest level measured 18 inches wide and assayed $3\frac{1}{2}$ oz. gold, silver 10 oz. and copper 20% per ton. The whole vein was 4 ft. wide. The ore in the other properties visited ran much lower viz: from \$2.00 to \$20.00 gold per ton. The miners are allotted small pieces of ground to work

The veins in this district of the prince's were like those just described, white quartz in porphyry and diorite. The gold was



free but of an exceedingly low grade. A legend is told there that one of the prince's ancestors was averse to mining on his territory, but that the ores were so rich that they were mined, surreptitiously by the Mongolians until one day he took the drastic measure of walling up the entrances to several of the mines leaving about fifty miners entombed. This happened forty years ago and effectually stopped mining in the territory. There is nothing now however to indicate rich veins in the vicinity.



SCALES FOR WEIGHING MONEY.

Through the drift in one place visited sandstone outcrops and in it are some narrow seams of coal, which the low prices of labor make possible to mine for local uses.

The levels in the mine were so low that we were obliged to crawl on our hands and knees 700 feet to see the breasts. Boys carry the coal through these drifts in wicker baskets much the same as women use for sewing

materials. Though the vein lies horizontal in a practically level country and is reached by a short incline so that a 100 foot deep shaft would cut the 700 foot level at its other end and save all this carrying of coal through the level, for some reason it is not considered feasible to sink such a shaft.

From there we went south to Pa-Kou, to examine some placer ground, where we also found the most primitive methods in use. The placer ground, beginning at the top of the gulch instead of at the bottom was being worked out by innumerable pits to bedrock and all the material taken out was panned by hand. Thousands of miners were employed who, like those in the case cited of the lode claims, had small pieces of ground allotted to them and were compelled to sell the gold which they obtained to a mining bureau at a rate per ounce fixed by it.

From Peking we had kept our road platted by compass sights and estimated daily distances of travel, which from time to time we corrected by taking our latitude and longitude, the former accurately with a transit and also the local time, but our watches were not running close enough for use in computation of longitude, which we were therefore obliged to get roughly by lunar sights. By comparison later however in Tien-Tsin with a map made by Mr. Hoover and staff for the Chinese government, we found ours to be practically correct and it had saved us from a great deal of trouble, for it had been our intention all along the way to return from Pa-Kou to Peking direct, a plan which was only altered after we had platted the railroad. We could readily do this from atlases we had along, which gave the course of the railroad from Peking to Tien-Tsin and thence along the coast. We were entirely unaware of the Boxer uprising at this time, but changed our course, because we found that we could save a couple of days time by continuing on our road south to the railroad at Tang-Shan. We could get no reliable information in Pa-Kou from any source as to the distance from there to the railroad, not even at the telegraph office where one official agreed closely with our estimated distance, but another made it double; and it may be stated here that this condition was prevalent all along our route; at any one place it was impossible to find out anything which could be relied upon, about another place fifty miles distant. Had we gone from Pa-Kou west to Peking, we would have arrived in a little village on the day that twenty-five Chinese Christians were murdered there.

From Pa-Kou south the formation becomes more sedimentary in character showing much sandstone and limestone, with quartzites and igneous rocks sparingly interspersed. To the southeast of us were some of the Chinese coal fields, but these we did not visit.

We reached the railroad town of Tang-Shan on the evening of the fifth of June, where for the first time we learned of the riots then taking place and on that account we chartered a train to move us and our belongings that same night to Tien-Tsin. The rails were torn up between Tien-Tsin and Peking the next day, which fortunately detained us in Tien-Tsin. We remained there



CHINESE SILVER MONEY.

ten days, taking the last train out, and reaching Taku the night of the bombardment of the forts. After six hours firing these were captured and we were enabled to steam out of the harbor for Shanghai.

The conclusion we reached from our examinations is that some of the territory travelled over is well worth prospecting, providing good titles can be obtained to it.

One of the most serious drawbacks to mining there is the scarcity of timber; the hills amongst which we traveled had been denuded centuries ago, and except for isolated bunches of poplars and cottonwoods the hills are bare. The country though is well watered with small streams and the Lon river is navigable for rafts and small boats from Jehol to the railroad. The destitution of the people along

our route was almost complete; except for the few rags on their backs and the little food they got from day to day by inscrutable means they had nothing, but their contentment too with these conditions was perfect. Their curiosity about us was insatiable, all along the road they would flock to see us pass and our arrival at an inn brought the whole village about our heels. Our clothes and all our possessions were minutely examined and their joy at the gift of an empty bottle was immense; often we would throw one into a crowd to see them scramble and fight for it. A matter of wonder to us was the scarcity of the crops. Along the road, although we were passing through an agricultural country, except in small patches, the ground had not been seeded at the time we left which was early in June. With nothing but rags and a little daily food, not even to have the latter, when winter comes on, will be hard indeed. It would verify the Scriptures; what Confucius has to say about it, I do not know.

THE TURQUOISE MINES

Of the Cerrillos Mountains in New Mexico—Said to Be the Largest Producers in the World.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

Turquoise is a mineral well known to all jewelers, and to many who love precious stones, for its beautiful, pure, blue-green or green-blue color. Artists sometimes use the term turquoise blue in describing those wonderful effects of color often seen in a sunset sky, sometimes in water, notably in the Animas River of Colorado, and many of the deep glacial lakes or tarns found lying like gems in the lap of some glacial amphitheater high up in the summits of our mountains, and in the ponds lying at the base of the geysers of the Yellowstone Park.

This beautiful gem is a phosphate of alumina. Dana gives it as phosphorus pentoxide 32.6, alumina 46.9, water 20.5. Before the blowpipe, infusible, but becomes brown and colors the flame green. Soluble in hydrochloric acid. Moistened with acid it gives a momentary bluish green color to the flame, owing to the copper present. The hardness is 6, specific gravity 2.6-2.8. It receives a fine polish. Green malachite or copper carbonate resembles it and is sometimes substituted by dishonest dealers for it, but malachite is softer and different in color. An artificial turquoise is made from powdered turquoise, cemented together and submitted to great pressure, but the imitation is softer than true turquoise.

Turquoise occurs usually in very sparing quantities in narrow seams in volcanic rocks. It is found in Persia; in Turquoise Mountain, Arizona, and in the locality we are about to describe, viz: The Cerrillos Mountains of New Mexico. In Persia the Persian King is said to retain for himself all the large and more finely tinted specimens.

The Cerrillos Mountains of New Mexico have long been celebrated for their turquoise mines, the largest of which are in the possession of the Tiffany Company of New York. Having occasion to visit the anthracite mines in this group of mountains, we paid a visit also to some of the turquoise mines or quarries.

The Cerrillos Mountains are a small isolated group of rounded and conical hills about 50 miles north of Albuquerque, New Mexico. They consist of an eruption of porphyritic rock, apparently of the class known as porphyrite or porphyritic diorite, among sedimentary beds of Mesozoic origin, the Jurassic and Cretaceous series being involved in the uplift, principally the latter. It is probably a laccolitic intrusion and from the central core intrusive dykes and sheets have greatly metamorphosed by heat the surrounding sedimentary strata which are largely Marine Cretaceous shales changed by heat into slates. At some distance from the central focus of eruption other sheets have locally altered at contact the coal of the Laramie Cretaceous into anthracite. Numerous veins of altered quartzose rock and true quartz veins, as well as altered dikes, have been worked for ore and at one time there was quite a boom in this region. The mines, however, have not so far proved very productive. The ores are principally galena, zinc blende, and pyrite, and are more silver than gold bearing.

The same heat and water agencies that deposited the precious metals were doubtless influential in depositing the turquoise or in altering the feldspars of the volcanic rock into that beautiful, phosphatic form.

The turquoise deposits occur in masses of a much altered and bleached feldspathic volcanic rock. They occur as veinlets in the quartz seams of the rock, also in nodules in talcose seams.

This turquoise region or locality appears to have been well known to and worked by primitive races, even, it may be, before the Spanish conquest. Indians coming from the north into southern New Mexico and Mexico were found with turquoise ornaments on them, some pierced in a wonderful manner by fine

holes, others beautifully worked. The turquoise was doubtless obtained from this locality. We find in one place near the summit of the most prominent hill a quarry over 100 feet wide by 100 feet deep with a shaft 40 feet deep at the bottom of it.

Growing in this quarry are large pifion trees of considerable age. There is no record otherwise of the date of this ancient quarry, nor any record of who were the people who excavated it. Stone axes and other primitive implements have been found in the district, but it is scarcely conceivable that so large a quarry could have been excavated in volcanic rock with such primitive tools. It is possible that they may have made some progress by heating the rock with fire and splitting it by pouring water on it. The hill which covers an area of a few acres is quarried and gophered in all directions both by ancient and modern hands.

The volcanic rock has doubtless been altered and bleached by ascending heated solutions which have deposited the turquoise in fine crevices and on jointing planes. We occasionally pick up fragments on the dumps which show a turquoise tint, but all that is valuable seems to have been carefully gleaned away. This same hill was worked to some extent by the Tiffanys some years ago and abandoned, nothing of importance having been found. It is supposed to be an upshoot of turquoise-bearing rock between lead veins and too near the lead.

Another turquoise deposit is the "Blue Bell" mine, situated $2\frac{1}{2}$ miles north of Cerrillos. The "Blue Bell" was an old Spanish working. But the most important mine of the whole district is "Old Castillian" located May 10, 1890, and now owned and operated by Tiffany & Company, of New York City. There was then an open cut 75 feet long by 30 feet wide and 16 feet deep, presumably done by the Spaniards. Mr. O'Neil worked the mine intermittently for about three years, sinking the shaft to a depth of about 60 feet. It was then sold, we were informed, to Mr. D. C. Hyde, of New York, who sold it to Mr. Mahoney, a former United States Consul to Turkey. The ownership passed from one to another until bought by Story and Allen, who after taking out about \$500,000 sold the mine in 1893 to the present owners for \$250,000. Information about the condition and output of the mine is at present hard to obtain, the works not being accessible to visitors. From the appearance of the mine-dump there has been some thousand feet of sinking and drifting. The mine is reported to be 300 feet deep. Turquoise in the "Old Castillian" occurs in talc or soft material as nuggets, in the form, sometimes, of a cluster of grapes. There is no regular vein, the talc being found in chutes and "vugs" not continuous.

This district is said to be the greatest producer of turquoise in the world, and while the money value is doubtless large, there is no great demonstration in mining and marketing the stones. Only now and then a small express package is seen going to the railway depot, that represents great wealth. A person could pass within a few hundred feet of the mine, and without being posted, would not surmise that anything of importance was being done. According to the published report of the Governor of New Mexico, "there are some sixty or seventy turquoise claims in New Mexico, and some ten or a dozen in active and profitable operation."

The output of turquoise in New Mexico as taken from official sources was, \$150,000 in 1891; \$175,000 in 1892; \$200,000 in 1893; \$250,000 in 1894; \$350,000 in 1895 and \$475,000 in 1896, but it is openly asserted that the true value of turquoise mined since 1890 has been greatly underestimated. As an illustration, one of these mines sold in 1893 for \$250,000 and according to the statements of a former owner, has paid a million and a half a year since that time. One single stone taken out is reported to have been bought in New York for \$8,000.

While some of these gems have been famed in Europe for centuries, in the United States they have never met the appreciation their merits and rank as gems deserve, until the last few years. Now they are in great demand, having been pronounced by experts equal, if not superior, to the Persian turquoise. There are single gems from Santa Fe County, now in New York, held as

high as \$4,000 and some in Santa Fe of nearly equal size and quality. This sudden appreciation has given a stimulus to further research resulting in finding large turquoise deposits near Silver City in the Hatchitas and Cow Spring Mountains of great merit.

The Jeffrey Air-Power Longwall Mining Machines.

The accompanying illustration shows the latest design of air longwall mining machine manufactured by the Jeffrey Mfg. Co., of Columbus, Ohio. A partial front view is shown. It is the disk or wheel type and self-propelling. Some of the main features are:

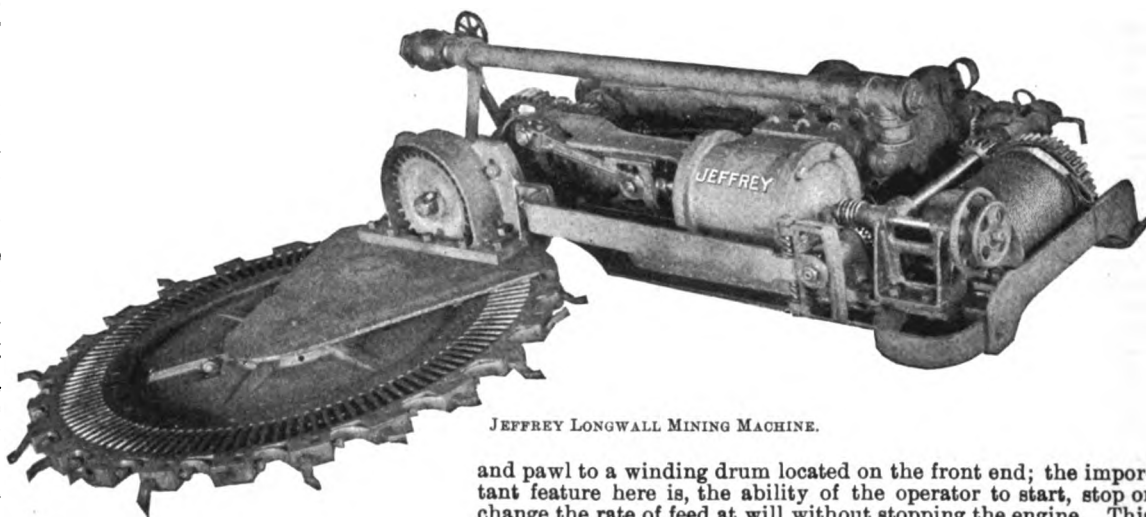
First.—That it runs on a single rail, the side thrust being taken by special ties and light screw jacks. The use of one rail reduces to a minimum the liability of jumping the track so common to the two-rail machine, a single rail is also much more easily laid.

Second.—It cuts its own floor, in other words, cuts on the floor level. It can be built, however, to cut at any height from the floor that local conditions require.

Third.—The disk or cutter wheel can be tilted up or down by means of a hand wheel at the front end of the machine; so that sulphur balls or other obstacles can be passed over or loosened if met with in undercutting, or on an uneven floor the irregularities can be easily followed.

Fourth.—The machine is designed to be operated from the front end, which enables the operator to lay his rail ahead of the machine; he can see that the roof and face are safe before the machine approaches and it also leaves more room in the rear for handling rails and spragging the coal.

Fifth.—The feed mechanism is driven by an eccentric on the outer end of the main drive shaft at the rear, through a ratchet



JEFFREY LONGWALL MINING MACHINE.

and pawl to a winding drum located on the front end; the important feature here is, the ability of the operator to start, stop or change the rate of feed at will without stopping the engine. This is recognized as a very desirable point, as it enables the operator to let the machine clear itself in case of a fall of coal on the disk. The rates of feed that are possible are 8 in., 15 in. or 21 in. per minute, thus enabling the same machine to cut a hard or soft grade of coal or clay without any changes in its construction.

Sixth.—The machine is constructed of steel throughout with the exception of the engines which are of cast iron, all gears are machine cut except the pinion driving the cutting wheel which is a rough heavy casting. The whole machine is very compact being only 6 feet $11\frac{1}{2}$ inches long, 35 $\frac{1}{2}$ inches wide without the wheel, and 20 $\frac{1}{2}$ inches high. It weighs about 3,000 lb. for a 48-inch undercut, and can be built for the following undercuts: 36 in., 48 in., 54 in. or 60 in. and from 4-in. to 6-in. kerf without any change in the machine, except the quadrant plate and wheels. The bed frame is cast in one piece and has cast to it the main bearing for the rocker arm that carries the quadrant plate and center wheel. The engines are 9 in. $\times$ 8 in. cylinders, designed to develop 25 horsepower with 40 lb. of air at the machine, and are provided with cast-steel cross heads, connecting rods, and crank disks. The eccentrics are arranged so that the engines can be reversed in a very few minutes without resorting to the link motion. The cutter wheel is of high-grade malleable iron made in halves and bolted together so one half can be removed and the other left intact with the machine; this enables it to be moved, from one part of the mine to the other without removing the wheel entirely. The quadrant plate is of boiler steel and carries a heavy self-oiling bearing for the cutter wheel. It is claimed that under favorable conditions this machine will cut from 600 to 800 lineal feet face per day. Further information will be given interested parties by the manufacturers.

THE LAKE COPPER INDUSTRY.

How It Has Expanded Within a Few Years by the Opening of New Mines and the Equipment of New Mills.

Written for MINES AND MINERALS, by H. J. Stevens.

A feature of the growth of the copper industry during the past five years which has been frequently overlooked by students of the copper situation is the marvelous expansion of the industry in the Lake Superior region, where copper was first mined at a profit and in appreciable quantities in this country. The opening of virgin fields and the upbuilding of new mining camps are more productive of the spectacular, yet the growth of the Lake copper district within the past five years has been much greater than that of any other important mining field in the country. It is true that the expansion in production within that period has not been especially marked, but this is due to local conditions, it being necessary to allow three to five years to get a new mine to the point of production in the Lake district.

The production of refined copper by the Lake mines for the year 1896 was 142,057,600 pounds, while for the current year it is not likely to greatly exceed 160,000,000 pounds, a gain of less than 15 per cent., which is less than the rate of increase of the United States as a whole. The work that is doing is better shown, however, by other figures. In 1896 the number of men employed in the district was 8,170, while in 1900 the force amounted to upwards of 14,000 men. Houghton county alone employed nearly as many men in copper mining and milling in 1900 as were employed in all the mines and mills, of copper, gold, and silver, in the entire state of Montana, one of the richest and most productive in mineral wealth of any among the fraternity of American commonwealths. In 1896 there were but ten active mines in the entire Lake copper district, and in 1897 this number was reduced, first by the closing of the Central, in Keweenaw county, thus confining the active territory to Houghton county alone, and later by the absorption of both the Kearsarge and Tamarack Junior mines by the Osceola company, leaving but seven active copper mines in the entire state of Michigan in the fall of 1897—much the smallest number for fifty years, or since the time when copper mining was first actively prosecuted, in 1844 and 1845.

The contraction in number of producers was accompanied by a corresponding contraction in the area of operations, which, at the time of the lowest ebb in the industry, in the fall of 1897, included merely a narrow strip of barely two miles width and fifteen miles in length, from the Atlantic, on the south, to the Kearsarge, on the north. The tendency toward contraction was checked, apparently, by the opening of the Baltic mine, six miles south of Houghton, which made such a promising showing that a company was organized late in 1897 to take over the prospect. This was done, and the Baltic is now making about 175 tons of mineral monthly and promises to develop into another Quincy. In 1898 the upward trend of copper and of copper shares led to the organization of several new mining companies, and the winter of 1898-99 was marked by the copper boom which has already become historical, during the existence of which more than a score of corporations were organized to operate mines or prospects in the Lake district. The smallest cash capital placed in the treasury of any of these new companies was \$60,000, in the Oneco, while the Isle Royale and Miners' companies, consolidated a little later, had each an even million of dollars in their treasuries, after expending hundreds of thousands for the purchase of mines and mineral lands.

At all of these new properties more or less work has been done, and at all but four or five of the weakest work is still in progress. The Arnold and Phoenix are actively working in Keweenaw county, and the Phoenix, although as yet without a mill, is producing an average of 16 tons of heavy copper per month, which very nearly pays all operating expenses of the property. In Ontonagon county there are no less than four active mines, where for many years activity was confined to the "gopherings" of the tributors, who scrambled the levels above the water line for masses of metal overlooked in the earlier days, the total product of the tributors reaching but a few tons annually. These Ontonagon county mines, the Victoria, Michigan, Adventure, and Mass, will soon be joined by a fifth, the Belt, adjoining the Adventure, where an English corporation frittered away a million and a quarter dollars in cash, some fifteen years ago, on extensive surface improvements, only to find, when the strong-box was empty, that they had forgotten to open a mine to feed the big stamp mill they built. In Houghton county the present active district reaches from the northern to the southern boundary line, and there are an even score of mines now working, where there were but seven less than four years ago.

Not all of these new mines are as yet producers, but a respectable number of them are turning out copper. The Centennial is

making a small amount of mineral with a single old stamp, aided by antiquated washing machinery. This is soon to be replaced by a modern mill, of large size, located on Torch Lake, opposite the mills of the Calumet & Hecla. The Franklin Junior, opened on both amygdaloid and conglomerate beds, is supplying the major portion of the rock treated at the fine new mill of the Franklin company. The Arcadian, adjoining the Franklin, is also a producer, and will soon place two or three shafts opened on the Mesnard epidote in commission. The Isle Royale will start its new mill within two to three months, and will become a large producer from the first, a vast amount of money having been expended on the property, and ample time taken to do everything properly, without attempting to begin production before conditions were fully suitable. The Baltic, as before noted, is making about 175 tons of crude copper monthly, and as soon as its new mill, now building, is finished, will increase this production to between 250 and 300 tons monthly, entering the same class as the Atlantic, Wolverine, and Franklin mines. The Trimountain and Champion, next south of the Baltic, and opened on the same lode, are to have stamping facilities, the Trimountain in a mill of its own, preliminary work on which is to begin this week, and the Champion at the Atlantic mill, where the two stamps now used by the Baltic can be turned over to the Champion when the Baltic relinquishes them on moving into its own new mill.

The joint product of these new mines did not very greatly swell the production of the Lake district for the year 1900, but will be more appreciable this season, and with every passing year henceforth the effect of the output of the newer properties will be more plainly felt.

The old mines are not idle; while new properties are being opened, the older mines have done their full share toward the expansion of the district. The Lake copper region is essentially a low-grade district. The best gold, silver and copper mining fields of the world, almost without exception, are low-grade districts, where profits of fabulous size are made by the treatment of large quantities of rock or ore, at a small profit per ton, rather than high-grade districts, where small mines return fabulous profits per ton, on small productions. The Calumet & Hecla stamps about two million tons of rock per annum—pulverizes the hard conglomerate rock to sand so fine that it will be carried along freely by a strong stream of water. Owing to the Lake district being of low grade, as before stated, profits can be earned only by the best mines, and at them only by working upon a truly colossal scale. Nowhere else in the world are there to be seen such gigantic machinery and such mammoth mills. In no other district is the cost of opening and equipping a mine so great—and, it may also be added, in no other district are the profits of the best mines so large as here.

By reason of the enormous investments required and the vast scale of operations, it takes years to accomplish results so plainly that they are visible to the most obtuse. Shareholders of many of the oldest and most prosperous mines of the district have been given to grumbling because of the enormous sums devoted each year to betterments and new work. There was a time when the officials of these corporations told the impatient shareholders that construction work was nearly at an end, but both officers and shareowners have learned better. There is no end to such expenditures for a healthy mine. If the new work stops, the mine will eventually stop also. Never before have millions been so lavishly turned back into the properties from current earnings as during the past three years of high-priced copper, by the old mines of the district. The Calumet & Hecla has opened a mine capable of making nearly or quite as much copper as the Quincy or Tamarack, on the Osceola amygdaloid, which parallels the famous Calumet conglomerate at a distance of 730 feet to the eastward. All this has been paid for out of current profits, notwithstanding which the Calumet & Hecla paid its shareholders profits of ten million dollars in the calendar year 1899—the largest sum ever paid by any mine in a single year. The Tamarack bottomed a new shaft, No. 5, some sixty days ago, after working at the sinking for more than five years. This shaft will eventually exceed a mile in depth, and is now down vertically nearly 4,700 feet. The Osceola has spent much money, both on surface and underground, and at last has modern and economical equipments of machinery at mine and mill. The Osceola company is also opening a large new mine, the South Kearsarge, between the Centennial and Wolverine, all this work, as in the case of the other mines named, being paid for out of earnings, in addition to the disbursements of dividends unprecedented in size.

The Quincy has perhaps done more in the way of renovation and making over than any other mine in the district, within the past four years, having expended an average of nearly half a million dollars annually on construction account. Buildings, machinery and stamp mills have been added to, rebuilt or replaced, and an equally large and important work accomplished

underground by the sinking of new shafts and the development of new mineral reserves. The new three-stamp mill of the Quincy is now in full operation, for the first month, and the mine is making more copper than ever before in its history.

The Franklin, which was a decadent property, with ultimate extinction apparently imminent five years ago, is now, phoenix-like, risen from the ashes of the flames that destroyed its old mill, and with a new and modern mill and a new mine, the Franklin Junior, as an auxiliary, bids fair to flourish for many years, while recent discoveries in the old mine indicate the existence of a rich cupriferous lode, heretofore unsuspected, paralleling the Pewabic amygdaloid, now nearly mined out on Franklin territory. The Atlantic, the southernmost of the group of the old-time mines of the district, has built itself a new railroad, a new stamp mill, a new dam, new machinery, and new shafts within the past seven years, and is more prosperous than ever before.

The amount of new work in progress in the district is far greater than ever before—greater than during any of the three preceding boom years. The Mohawk and Wolverine have let contracts for new mills to be built this year. The Calumet & Hecla is building a new mill of six stamps and the Osceola is completing one of three stamps. The Quincy has just completed its new three-stamp mill and the Isle Royale is putting the finishing touches on one of the same size. The Mass has a new mill partly up, as also has the Baltic. The Centennial is to build a new mill this season, and the Trimountain also, and the Adventure is to have a mill just southwest of the Trimountain. Among the properties which will probably build mills soon are the Phoenix, Champion, Michigan, and Victoria. As it is, there are new mills now under construction or contract having a capacity of 30 stamps, each stamp capable of treating 500 tons or more daily, and each stamp averaging from \$60,000 or \$75,000 in cost, including therewith the necessary washing machinery, buildings, boilers, pumps, etc.—a total of two million dollars going into new stamp mills in this district this year.

Safety-Lamp Cabin at Heworth Colliery.

By Thomas V. Simpson.*

The passing of the Coal Mines Regulation Act in 1896, having made it expedient that a new safety-lamp cabin should be erected and that the safety lamps should be cleaned at the mine, the following arrangements were designed by the manager:

The lamp cabin, Figs. 1 and 2, is built so as to bring the safety lamps all to one point for cleaning, and to six points for distribution. For this purpose, the lamp stands—circular and revolving—are placed in a circle around the cleaning machine. By this method, a person standing at the machine can, by turning the lamp stands, almost reach every safety lamp in the cabin, with very little movement of his position.

There are 12 lamp stands, each carrying 100 safety lamps. The stands, Figs. 3 and 4, are made of wrought iron, fitted with 5 pairs of shelves, one shelf in each pair being placed behind the other; the front one holding the lamp bottoms and the back one the lamp tops; and each pair of shelves holds 20 lamps and have numbers attached to them in rotation corresponding with those upon the lamps. The shelves are 10½ inches apart, the lowest being 2 feet 6 inches above the ground. The tops of the stands are joined to each other by means of a circular ring which passes around the cabin, and is fastened by means of stays to the sides of the building. The bottom ends of the axles of the stands rest in bearings, whose tops are made cup shaped so as to contain oil.

The walls of the cabin are circular and 18 inches thick Figs. 1 and 2. There are six windows, at which the lamps are handed out to the workmen, and two stands are conveniently placed adjacent to each window. The entrance door is placed at one end of the building, and at the opposite end there is a door leading to the repairing shop. Outside the wall of the cabin, and 4½ feet distant from it, is another wall, 9 inches thick, enclosing a passageway traversed by the workmen while getting their safety lamps. The structure is covered by a glass roof, so as to obtain a good light. The floor is made of cement, and except for the windows, doors and cleaning machine, there is no wood which can become saturated with oil or catch fire.

The double lamp-cleaning machine is driven by a small steam engine.

The oil taps are placed at each end of the cleaning machine, the oil being conveyed in pipes from the storehouse.

There are 10 men and boys employed in cleaning the lamps, divided into two shifts of 12 hours each, from 6 to 6 respectively. Two men in each shift hold written authorizations to lock the safety lamps. One man repairs the lamps during the day time, when the men are not so busily engaged in cleaning lamps. At

night time, all of the workmen attend to the cleaning of the lamps, the odd hand supplying oil to the lamp bottoms, while the others, working in couples, clean the lamp tops.

In order to prevent a lamp from being given out unlocked, one man lights it, while it is on the stand; a second man follows, screws the top and bottom of the lamp together, and places it on the window sill; the authorized man locks it, and places it on the floor; the last man replaces the lamp in its position on the stands; and thus it is practically impossible for the locking of a lamp to be omitted.

The lighting of the lamps is effected by means of a small tin pot filled with paraffin oil; a long spout is attached to this pot containing a wick, so that when the lighting wick is placed next the lamp wick, a drop of paraffin oil runs down the spout and falling upon it, causes it to ignite immediately. It is proposed to adopt electric lighting and locking of the lamps. The safety lamps used at present are fitted with the ordinary screw with a flat head. Colza oil is used in the lamps.

The cost per lamp per week for the first half year of 1900 was: Materials, 1½d, labor, 2d; making a total of 3½d per week. The cost is somewhat high, owing to the prevailing rate of wages being above the basis.

The safety lamps in use are: Mueseler lamps for hewers, stonemen, shifters and wastemen; Donald lamps for deputies and boys; and Marsaut lamps for officials. The revolving stands used for the various types of safety lamps are marked on the plan, Fig. 2, *H*, for hewers; *S*, for stonemen, etc.; *W*, for wastemen,

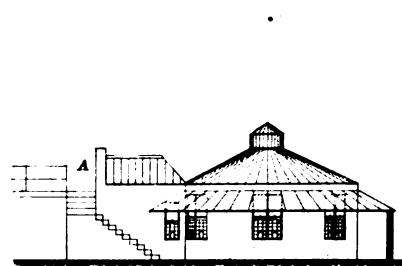


FIG. 1.—ELEVATION OF SAFETY-LAMP CABIN, WITH OUTSIDE WALL REMOVED—SO AS TO SHOW WINDOWS.

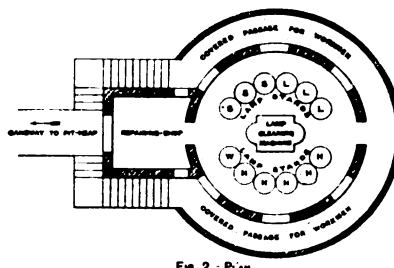


FIG. 2.—PLAN.



FIG. 3.—PLAN OF LAMP STAND.

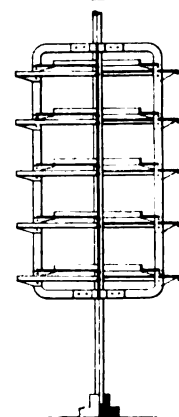


FIG. 4.—SIDE ELEVATION AND SECTION OF LAMP STAND.

and *L*, for lads. The deputies take their lamps home to clean, as they prefer to have their gauzes exceptionally bright and well cleaned.

The workmen, who have safety lamps, hand in a token before they receive their lamp; the number on the token corresponds to that of their lamp, and when they return the lamp the token is handed to them. The token is placed on a hook attached to a board, placed at the side of every window, so that each stand has its own board containing 100 tokens. Adjacent to each hook is a cardboard label, containing the man's name and number, and by this means it is possible to ascertain who is down the pit and who is not. After receiving his lamp, the workman walks up the stairs to the pit heap.

Slates, hung between the boards, where the hewers' lamps are kept, record the names of those in opposite shifts, different shifts being written on opposite sides of the slates, so that by turning the slate each week, the workman knows which lamp to light in the fore shift.

All lamps requiring repairs are given in at the window of the repairing shop, so as to keep them separate from the others in the cleaning room.

A barometer, a thermometer, a copy of the abstract of the Coal Mines Regulation Act, and the Special Rules are placed at the end of the gangway *A* adjacent to the lamp cabin, Fig. 1.

The arrangements just described have been in force for three years and have worked satisfactorily.

*A paper read before The Institution of Mining Engineers, England.

THE LIBERTY BELL MINE.

A Description of Mine—The Ores—Difficulties in Successfully Treating Them—Methods of Transportation.

We spent part of the last summer in the San Juan Mountains of Colorado, and in previous articles have described some of its very peculiar mines. We have also noticed the prevailing use of the bucket-tramway in that region necessitated by the terrific steepness of the mountains and cliffs.

In the Transactions of the Society of Mining Engineers for 1899, Mr. Arthur Winslow gives an account of the Liberty Bell mine of Telluride, which is typical of an average great San Juan mine, and illustrates many of the peculiar features and difficulties to be met with in mining in that grand but precipitous region.

The Liberty Bell Mine is situated near the town of Telluride and near the summit of the Uncompahgre range, 11,000 feet above the sea. In the vicinity are the Smuggler Union mine with a record of \$12,000,000, the Virginus and Revenue Tunnel group with a production of over \$5,000,000, and the Tomboy of \$3,000,000.

The first prospecting of the district was in 1875, when the Smuggler vein was located; the nearest railway point was then 250 miles away, and only the richest ores could then be mined profitably. Now branches of the Rio Grand Railroad traverse the district to the very foot of the dumps of some of the mines.

The Liberty vein was discovered by the crossing of it by a stream, and showed free gold on the outcrop. The vein is a strong fissure maintaining itself in length and depth. The vein occurs cutting the andesitic volcanic breccia, or "San Juan formation" consisting of a bluish-gray breccia of angular fragments of andesitic lava cemented by a bluish matrix of the same material. The fragments according to Dr. Whitman Cross were ejected from volcanic vents, and received their stratified arrangement in the

The vein has been found to be practically one continuous chute of low grade ore for a distance of about 2,000 feet.

The results of assays showed that the values were about two-thirds in gold, one-third in silver.

Preliminary amalgamating tests indicated that the larger part of the gold was free milling and probably 70 to 80 per cent. of the gold could be saved on the plates by ordinary concentration methods. The reverse, however, was the case with the silver. Only a small fraction of the total could be caught by amalgamation, and not much more by panning. Tests on a large scale were then undertaken, including stamp mill runs of several lots aggregating 45 tons with vanners and "Triumph" tables for concentration. Cyanide tests on raw or roasted ores were made; a lot of 200 pounds was treated by pan amalgamation, and special lots were tried on other concentrating tables.

The stamp milling and concentrating tests gave savings varying from 54 to 78 per cent. of the gold, and from 14 to 30 per cent. of the silver. The loss of silver was still excessive, and that metal seemed to be in an elusive form which no ordinary concentrator would save.

Cyanidation gave an extraction on raw ore of about 85 per cent. of the gold and 50 per cent. of the silver. On roasted ore the extraction was smaller. Concentration by panning followed by cyanidation of the tailings gave a saving of 50 per cent. gold and 15 per cent. silver in the concentrates. The extraction from tailings by cyanide solution amounted to 36 per cent. of gold and 54 per cent. silver, or a total of 86 per cent. gold and 70 per cent. silver. Pan amalgamation gave a saving of from 64 to 82 per cent. of the gold and from 31 to 42 per cent. of the silver, and amalgamation combined with cyanidation gave a saving of 76 per cent. of the gold and 44 per cent. of the silver. The result of these experiments was the adoption of a combination process of stamp milling, followed by concentration, and a supplementary slime treatment. The amalgamation is very free and quick, the first of the three



CHARACTERISTIC SCENERY OF THE SAN JUAN REGION NEAR TELLURIDE, COLO.

waters of a lake and possibly by falling in showers on slopes adjacent to the volcanic vent. (In the accompanying pen sketch from a magnificent photograph by Mr. H. C. Moore of Telluride, justly entitled "grandeur" the mountains are all of this San Juan breccia formation resting on a base of granite.) Veins in this district are strong, and commonly about five or six feet wide. From the heights, the croppings of the veins can be traced for distances of a mile or more, by a discoloration of the surface, and by notches, or sharp depressions in the outline of the hills, the result of more rapid weathering along the vein fissure. The walls of the Liberty-Bell vein are well defined, smooth, and slickensided. The vein material consists of quartz and silicified earthy matter in bands, or layers, between which are layers of soft gouge, or clay of a dark brown or black color such as are commonly found in the hanging wall.

The quartz layers are sometimes hard and dense, sometimes shattered and friable. Calcite occurs at times. A greenish slaty gangue is almost always present and sometimes occupies nearly the whole vein space. It is derived from the attrition of the country rock when the vein-fissure was formed, and is often silicified. It generally contains pyrite diffused through it in minute grains, but is practically valueless. Pyrite is diffused through the other vein rock also, with particles of iron and manganese oxides, constituting the bulk of the concentrates. Free gold is occasionally visible in unaltered quartz, and in thin coatings. Some of the black "gouge" runs very high in gold or silver. Gold is also associated with the pyrite. The values of the ore vary greatly in different places; samples show from a trace to \$100 in gold, and an average of \$30 to \$40 per ton in shipments.

The first thorough examination of the property included a systematic sampling throughout all levels. The method pursued was to break down and catch in canvas large quantities of material at regular intervals across the entire section of the vein. Each lot was then roughly broken down and quartered, yielding samples of 25 to 150 pounds.

apron plates catching probably 80 per cent. of the total product from these plates. Runs so far show that about 65 per cent. of the gold, but only five per cent. of the silver can be saved on the battery plates. The amalgam is exceptionally low grade, yielding about 20 per cent. bullion with fineness of 560 gold, and 420 silver. No advantage was found from inside plates in the mortars. Quicksilver is fed to the mortars, but very little amalgam is collected from the mortars in the clean up. A 20-mesh screen has been used with a double discharge mortar, and a daily crushing capacity of five tons per stamp has been reached at times.

The concentrates in runs with single concentration vary from one in 40 tons to one in 80 tons of the ore stamped. The value is from \$40 to \$60 per ton equally of gold and silver. Only about 5 per cent. of the total gold and 15 per cent. of total silver has been saved in concentrates. The entire saving by amalgamating and single concentration is about 70 per cent. of the total gold and 20 per cent. of the total silver. The silver extraction is very unsatisfactory. The loss in the tailings may exceed three dollars per ton, mainly in silver. The values in the tailings seem to be nearly uniformly distributed in both the coarse and fine product, but the silver predominates in the latter which is of the character of a cream.

Tests on stationary canvas tables have yielded promising, but not entirely satisfactory results. Leaching tests encounter a difficulty in obtaining a satisfactory percolation, and agitation may be necessary. The problem is a difficult one, and its solution means a great deal to many of the mines of the neighborhood, where even greater values than at the Liberty Bell are flowing away in the tailings.

The mining methods are those usual in any fissure vein. The vein is wide and contains much soft material and is easily mined, one man being able to break down 8 or more tons per shift.

The levels are timbered with stulls and hitches, and often with square sets. Stulls are placed at frequent intervals in the stopes, and such waste as is made is allowed to pile up on the

lagging and stulls over the level. Facilities for tunnel-mining are excellent. From a cross-cut ore is trammed in trains directly to the crusher bins.

The lowermost tunnel will tap the vein at 2,600 feet, horizontally from the adit mouth, and 900 feet on the slope of the vein below level No. 1. The turntable of the cable tramway is at the mouth of this tunnel.

The equipment consists of boarding and bunk houses at the mine, a trestle and snow shed 400 feet long from the tunnel mouth to the crusher bins; a two-mile cable tramway, similar to the Bleichert tramway of the Trenton iron works, with upper and lower terminals; a turn and tension station, and a mill at the lower end of the tram with office, assay laboratory, etc.

The crushers are located at the upper terminal away from the mill to save wear and tear on the tramway, by furnishing only crushed ore to the buckets. One sectional crusher of the Blake type, with 11 x 18 inches jaws is installed. Gearing is supplied for utilizing the power developed by the tram for crushing the ore.

The mill has an excellent side location with a fall of 80 feet from the top of the bin to the lowest concentrating floor, which is 10 feet above the railway switch. The mill was built in sections designed for 80 stamps, or 16 batteries.

The crushed ore is delivered from the tram directly into a large storage bin running the whole length of the mill. It is 25 feet high, 140 feet long with capacity of 2,000 tons. The ore is delivered from the bin to the stamps by chutes and automatic "hanging feeders" of the Challenge type. The mortars are deep and narrow, of Homestake pattern, with double discharge. Total weight of stamps is 850 pounds with drop of seven inches. The three apron plates of the first 20 stamps have an aggregate length of 12 feet, and are each 54 inches wide. From the plates the pulp passes through hydraulic sizers to the first concentrating floor.

From the first series of concentrators, the coarse tailings will be taken to a Huntington mill for regrinding, and thence over a second series of plates, to the second concentrating floor. The fine tailings from the first concentrating floor, and the entire tailings of the second concentrating floor will probably be subjected to some further slime treatment.

The mill is operated by water power supplemented by electricity; one six-foot and one two-foot Pelton wheel have been installed. The latter is used for the concentrating tables. Water from Trail Creek is conveyed to the mill by an eight inch pipe 3,000 feet long. The working pressure is over 350 lbs. to the square inch.

The flow of water is from 150 gallons to a maximum of 1,000 gallons per minute; owing to the late summer, it gradually diminishes to barely enough to run five stamps and the concentrating tables.

That all the water may pass through the wheels, a large two feet tail race from these wheels is conducted the whole length of the mill immediately below the ore bins, and is tapped at intervals to supply the batteries and concentrating tables. This tail race acts as a tank or storage reservoir for the mill with a constant pressure.

Electric power is furnished at a contract rate per month by the Telluride Power Transmission Company, and the mill and other buildings are heated by steam.

"Universal" Hand Oil Pump.

The "Universal" hand oil pump, here illustrated and made by the Lunkenheimer Co. of Cincinnati, is preferred by many to the lever pattern which the same company originated and has sold for over twenty years.

This pump is easy to attach, fill and operate, and works well

under high pressure. It can be made to attach either vertically or horizontally by transposing plug B and shank A which are interchangeable. This is an improvement as it permits of adapting the pump to meet any requirements of position: i. e., it can be connected either into the steam pipe or steam chest. As shown in cut it is arranged for vertical connection.

The filling-hole is closed by a hinged cap, which keeps out dust and dirt, and in addition, there is a removable wire gauze strainer to insure clean oil.

All parts about the pump are heavy, large, well constructed, and not liable to get out of order easily. These pumps can be furnished with brass instead of glass body as shown in cut.



Curtis Die Stocks Electrically Operated.

Electric motors are now being utilized for running machinery of all kinds wherever practicable, and the latest application of an electric motor to the Forbes patent die stocks, is highly practical and desirable, especially where a machine is moved from place to place as often as the work on which it is engaged is finished.

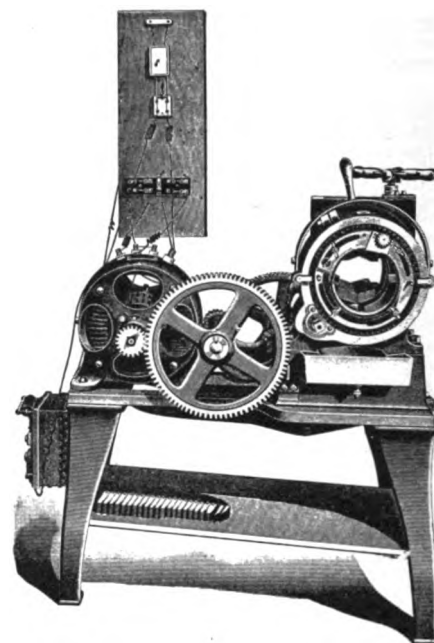
To meet this requirement, the Curtis & Curtis Co. has equipped the Forbes patent die stocks with direct connected electric motors shown in the accompanying illustration. These motors can be supplied for any desired voltage, and they are so arranged that a varying speed can be obtained, suitable for the different speeds at which it is desired to run the pipe machine.

It will be found that this equipment is very convenient when doing outside piping, as a machine and motor can be carried to the work, connected to some convenient electric current, and the work done on the spot without the work being carted to the machine.

It often occurs that piping has to be done in unfinished buildings, or in factories on a holiday, or during repairs to the boiler plant when it would be impossible to get steam pressure, so that electric power would be the only available way of cutting a pipe excepting by hand power. For these uses this equipment will be found invaluable.

The Curtis & Curtis Co. is prepared to furnish these motors separately from the pipe machine. When furnished in this way they are belted from the motor to the countershaft, and from the countershaft down to the pipe machine. While not so convenient, when arranged this way, for carrying the machine from place to place, as the countershaft would have to be taken down and put up again, it has the advantage for small shops, that other machinery besides the pipe machine could be run from the motor. If the motor was made large enough, or, if the pipe machine was not in constant use, grindstones, drilling machines or other tools might be run by it.

The company is prepared to furnish these motors from one to fifteen horsepower and arranged for 115, 230 or 500 volts, and full particulars, prices, etc. will be sent on application to the Curtis & Curtis Co., 4 Garden St., Bridgeport, Conn., by mentioning this publication.



CURTIS ELECTRICALLY-OPERATED DIE STOCK.

Increase In Bituminous Mines.

There has been a remarkable increase in the Pennsylvania bituminous mines in the past ten years.

In 1891 the number of bituminous coal mines in operation in Pennsylvania was 705, while on January 1st, 1901, the number had increased to 943, an increase of 238, or more than twenty-five per cent. Somerset and Armstrong counties have doubled the number of their mines, and Cambria county almost so. In the past decade Allegheny has gained thirteen; Armstrong, eleven; Beaver, three; Bedford, five; Butler, three; Cambria, fifty-four; Center, twelve; Clearfield six; Elk, nine; Fayette, thirty-two; Huntingdon, four; Indiana, sixteen; Jefferson, eleven; Somerset, thirty-four; Washington, six, and Westmoreland, twenty-six. The counties showing losses are: Blair, one; Bradford, three; Mercer, five, and Tioga, three. The remarkable increase has been greater during the period 1899-1900 than in any other year of the decade.

Captain Baird Halberstadt, of Pottsville, formerly assistant geologist of the Geological Survey of Pennsylvania, has just completed an elaborate and extremely valuable map of the bituminous coal fields of the State, showing the undeveloped and developed areas with the location of every commercial coal mine of these regions.

PERSONALS.

Hon. E. B. Craig has resigned the treasurership of the Virginia Coal, Iron & Coke Co., being succeeded by W. R. Wills.

Mr. George Dewar Macdougall, of the Wabana Mines of the Dominion Iron & Steel Co., Bell Island, Newfoundland, was a recent visitor in Scranton, where he came to investigate anthracite mining methods.

John D. Gilchrist, formerly of Bessemer, Mich., and at one time superintendent of the Mountain Iron Mine, has been made superintendent of the iron ore properties of the Colorado Fuel & Iron Co., in Wyoming.

Mr. F. C. Keighley, who has been superintendent of the Oliver Mining & Coke Works, Uniontown, Pa., from the time of their inception, ten years ago, has been made general superintendent of the Oliver & Snyder Steel Co.

Dr. J. S. Wentz, Mauch Chunk, Pa., has been elected president of the upper Lehigh Coal Co., to succeed the late Hon. John Leisenring. Dr. Wentz is the owner of the Hazlebrook and Silverbrook collieries, and an experienced operator.

Mr. S. B. Thorne, formerly comptroller of the Penna. Coal Co., has been appointed manager of the Temple Coal & Iron Co., of which Mr. T. H. Watkins was formerly general manager, and of which Mr. Baer, of Philadelphia, is now president.

Mr. Geo. K. Williams, of St. Francois County, Mo., has been appointed State Inspector of lead, zinc, and iron mines. The new inspector is a diamond drill operator from the lead mines of Southeastern Missouri. His address is Jefferson City, Mo.

Leslie Griscom, who has been with the Diamond Drill and Machine Company for the past 27 years, has accepted the position of sales agent for the M. C. Bullock Manufacturing Company, of Chicago, for the Middle and part of the Southern States, with office at Room 587 The Bourse, Philadelphia, Pa.

Mr. Geo. E. Hubbard, of 123 North 4th St., Philadelphia, Pa., has been appointed special agent in that city for the Ashton pop safety valve and steam gauges made by the Ashton Valve Co., 271 Franklin St., Boston, Mass. Mr. Hubbard assumes his duties April 1, and after that date will be very glad to receive the patrons of the Ashton Co.

Mr. W. S. Ayres, mining and mechanical engineer, has opened an office in Hazleton, Pa. He will give special attention to examinations and reports and to consultations as to methods of mining and the design, equipment, and installation of new plants. Mr. Ayres has recently been appointed consulting engineer for the Dominion Iron & Steel Co., for the large mining operations on Belle Island, Concepcion Bay, Newfoundland. This company, it will be recalled, is the Canadian rival of the United States Steel Co.

Mr. L. M. Rice, C. E., now of Seattle, Wash., who in 1899-1900 was engineer in charge of the several survey parties the Canadian Pacific Railway Company had at work in the Boundary district of British Columbia in connection with the location of the route and construction of its Columbia and Western Railway from Robson, on the Columbia River to Midway, Boundary Creek, is again in the district, this time for the purpose of selecting a route and making a survey for the electric tramway between the towns of Greenwood and Phoenix. It is intended that the tramway shall serve for the transportation of ore from the mines at Phoenix to the smelters at and near Greenwood, as well as for passenger traffic.

The following appointments of examiners of applicants for mine inspector, mine foreman and applicants for miners' certificates have been made by Judge Halsey of Wilkes-Barre.

Examiners for mine foremen in Third inspection district—Joseph L. Cake, John Monahan and David P. Williams.

Fourth inspection district—Edward Mackin, Frank Mills and Thomas Lloyd.

Fifth inspection district—N. C. Drake, Patrick Smith and George Magee.

The examining board for candidates for Inspector of Mines in the counties of Sullivan, Carbon and Luzerne appointed are: W. A. Lathrop, A. C. Leisenring, Joseph Samik, John Ross and James Airey.

Miners' examining board for the examination of miners for mine certificates as follows:

Third district—Patrick Cullen, John J. Dougherty, John Duddy, George Hilbert, Paul Woods, Patrick Wynne, W. H. Jenkins, John Ryan, John Gill.

Fourth district—W. D. Morgan, Thomas H. Reese, Joseph Featherstone, Edward J. Dowling, Ralph Turner, Patrick McGrane, Daniel W. Reese, Michael H. Crogan, John Flynn.

Fifth district—James Rhoda, Stephen Charles, Condy Boyle, John S. Davis, William McGinty, Matthew Welsh, James Brogan, James Bottoms and Isaac Williams.

Tennessee Mining Statistics for 1900.

The following statistics have been furnished MINES AND MINERALS by Hon. R. A. Shiflett, Labor Commissioner and Inspector of Mines of Tennessee:

Total number of coal mines in the State	114
New mines opened during the year	14
Number of coal mines reported active	100
Total tonnage produced	3,904,048
Average value per ton of coal at mine	\$1.10
Total value at mines of coal produced	\$4,294,228
Maximum number of employees in coal mines	8,691
Number of draft animals at coal mines	1,098
Average number of days worked in coal mines for the year	280
Number of fatal accidents reported	10
Number of non-fatal accidents reported	84
Tons of coal produced to each fatality	890,404
Number of employees to each fatality	869
Tonnage of coal used in the manufacture of coke	946,597
Tonnage of coke produced	494,458
Total value at ovens of coke produced	\$1,186,655.20
Maximum number of employees engaged in coke making	498
Tonnage of brown ore produced	378,345
Tonnage of red iron ore produced	821,876
Total tonnage of all varieties of iron ore produced	699,724
Maximum number of employees engaged in iron mining	956
Tonnage of copper ore produced	116,000
Maximum number of employees engaged in copper mining	886
Tonnage of zinc blende ore produced	8,968
Maximum number of employees engaged in zinc mining	88
Tonnage of barytes produced	16,605
Maximum number of employees engaged in barytes mining	258
Tonnage of phosphate rock produced	450,866
Maximum number of employees engaged in phosphate mining	2,999
Number of mines ventilated with fans	30
Number of mines using rope haulage	26
Number of mines using mule haulage	87
Number of mines using electric haulage	1
Number of drift mines	108
Number of shaft mines	8
Number of slope mines	8
Number of coal-cutting machines used	28
Number of kegs of powder used in mining	48,982
Number of pounds of dynamite used in mining	19,571
Number of coking establishments	18
Number of ovens	1,923
Number of ovens in blast	1,682
Number of ovens built in 1900	188

An Old Miner's Opinion of the Coal and Metal Miners' Pocketbook.

"That I am well pleased with the book is putting it very tame, for I am more than pleased. I am 62 years old in June, and have worked in mines for 55 years, and never in all that time have I seen anything in book form to compare with 'The Coal and Metal Miners' Pocketbook.' If such books had been published in my young days it might have made some difference with me.

The Colliery Engineer does not need to send any premium; it is well worth the money paid. I have been a subscriber since February, 1882.

JAMES DUFFY, Weir City, Kan.

Cost of Dredging.

A recent catalogue of the Risdon Iron Works, entitled Gold Dredging Machinery, gives some very interesting costs of operating the Kia Ora dredge. These costs cover a period between May 20, 1899, and July 28, 1900.

Total amount of wages paid	\$ 8,407.89
Total cost of repairs	2,520.71
Total cost of fuel	2,656.34
	\$13,584.94
Cubic yards lifted	297,220
Average cost per cubic yard	4 1/2 cents.

This cost includes running of river pump, which for the first nine months was a very expensive item, as owing to a temporary steam engine being used, the fuel consumption for the pump alone was two-thirds of the fuel consumption for the dredge, and approximately one-fifth of the wages cost of the dredge. Now that the pump is being operated by electric power, the cost is being very much reduced, last month's pump bill being only \$16.30, and the power bill for the dredge \$184. Up to December 8, 1900, excluding the cost of pumping, the average cost per cubic yard comes out at 3 1/2 cents.

The International Mining Congress.

The legislature of the State of Idaho has appropriated \$5,000 towards the meeting of the International Mining Congress which will be held in Boise City, Idaho, during July, 1901. Commissioners will be appointed by the governor of Idaho to take charge of the local arrangements.

The secretary of the congress, Mr. Irwin Mahon, Carlisle, Pa., reports that prospects for a successful congress are most encouraging.

Mines and Minerals

FORMERLY THE COLLIERY ENGINEER AND METAL MINER.

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CROSSCUT TUNNELS.

IN the history of many mining companies there comes a time when the question arises "Shall we tunnel across the measures?" This question is one which is apt to confront a mine manager at any time and it is almost certain to arise at some period of his career.

Just at present, there is great activity in tunnel mining in Colorado, and numerous crosscut and adit tunnels are now being pushed to completion; the future of some of the best known mines seems to depend upon whether or not they can be drained by means of crosscut tunnels. These mines have reached water level, enormous quantities of water have been encountered, and it seems impracticable to drain them otherwise than by means of crosscut tunnels.

In general the pumps are able to keep the water under control, but sometimes as in the case lately of the Elkton at Cripple Creek, it exceeds, temporarily at least, all bounds. The natural way out of such a predicament would be a tunnel more or less long, if possible along the vein, to daylight in some deep cañon in the vicinity. But few mines are so fortunately situated as to be able to reach such an exit within reasonable distance along an adit tunnel on the vein. If they are to be unwatered at all the course of their vein may be such as to demand a crosscut to it and the length of this may be far beyond the means of the mine. Consequently they must fall back upon some one of those long crosscut schemes, such as the Newhouse and similar tunnels undertaken usually by outside parties for various motives, to relieve them. In such a predicament are most of the Colorado mining camps. Central City awaits the arrival of the great Newhouse tunnel, some 4 or 5 miles in length, to relieve its deep more or less waterlogged mines. At Idaho Springs the Lamartine mine would have been closed down permanently had they not, as a last resort, run their two-mile tunnel, part adit and part crosscut, out into Clear Creek Cañon.

The once producing silver mines of Democrat Mountain at Georgetown have for the most part long lain comparatively idle on reaching a depth of a few hundred feet because of superabundant water. These await the Kelly tunnel, projected for some two miles in length to unwater them.

Cripple Creek, once the driest of all the Colorado Camps now finds its mines at a moderate depth, encountering in some cases an almost overwhelming amount of water. For most of these mines there is no natural relief or exit by an adit tunnel along the courses of their veins. These must await relief from the various projected crosscut tunnels, undertaken mostly by outside parties, such as the Moffat, Chicago, Cripple Creek, Good Hope, Standard, and others. The mines of Smuggler Mountain, Aspen, have already been relieved by the great Cowenhoven tunnel. In the San Juan the Revenue tunnel was driven mainly from the same water necessity. The Yak tunnel at Leadville will doubtless be a great relief to many of the deeper mines encountered in its course in the matter of water, a sample of whose burthen may be seen in the "Downtown mines" at present, whose position does not well admit of a long relief tunnel, and whose water has to be controlled by powerful pumps. Whatever be the original motive or outcome of many of the great crosscut tunnel schemes projected and being carried out in the various camps, their completion becomes a necessity and will be a great boom to many of those camps.

Tunnel schemes of the Brick Pomeroy type have caused many persons to look askance at any tunneling proposition, but it should be remembered that there are tunnels and tunnels. A drainage tunnel is in many cases a straight out and out engineering proposition, about which there is no more uncertainty than in many other engineering undertakings. Given a certain length of tunnel to be driven and knowing approximately the character of the rock to be penetrated, the cost of such a tunnel can be calculated with a fair degree of precision. When the tunnel is once completed, the cost of maintenance is practically nothing, and it is

then simply a question of what revenue can be obtained from the companies benefited by the tunnel, in case the tunnel is driven by parties not directly interested in the mines, or if it is driven by the mining companies themselves, its success as a business proposition hinges upon the accuracy of the estimates made as to the amount of material which can be extracted from the area drained by the tunnel.

Tunnels driven for prospecting purposes are, however, entirely different propositions, and a person who goes into them as a business venture must expect a large amount of uncertainty. They are supposedly based upon geological probabilities, but as there is nothing more uncertain than the continuity and uniformity of vein deposits, there is a very large element of chance in any such proposed tunnel.

A drainage tunnel, in which the prospecting element is not considered, is a business proposition, and in addition to its success as a drainage scheme, there is great likelihood that as a prospecting adventure it may also prove profitable.

In a series of articles which will appear in *MINES AND MINERALS* in the near future, Professor Lakes will take up a number of tunnel schemes which have been, and are at present, being put through in Colorado.

A STRIKING ENDORSEMENT FOR MINES AND MINERALS.

THE following letter shows conclusively the appreciation in which *MINES AND MINERALS*, as a mining and metallurgical journal, is held by prominent mining men. Naturally we receive numerous commendatory letters from individual subscribers or other friends who subscribe for several copies, but the following is of so striking a nature that we take pride in publishing it:

"ANACONDA COPPER MINING CO.,

"OFFICE OF PRESIDENT, BUTTE, MONT.

"Mr. Scallion, the President of this company is so much impressed with the value of your publication that he has decided to make a present of your journal to each one of the shift bosses in the mines and a copy of the journal and *The Coal and Metal Miners' Pocketbook* to each of the superintendents. Enclosed please find New York draft in payment, and list of parties to whom *MINES AND MINERALS* and *Pocketbook* are to be sent.

Yours very sincerely,

D. W. BRUNTON."

The list of names consisted of four superintendents and 49 shift bosses employed by the great Anaconda Copper Mining Co.

DEVELOPMENT IN ENGLAND'S COLONIES.

THE English character when it gets out from under the influence of the insular surroundings of the home country and has to grapple with pioneer difficulties seems to develop along very similar lines wherever this development takes place. In Australia, in South Africa, and in Canada, the English speaking race of today resemble very much more closely the same race in the United States than in the mother country; we find the same predominating characteristics of push and independent action, and the same freedom from the prejudices and strong attachment to precedents that have done so much to retard the mechanical development of the English people at home.

New Zealand with a population of less than 1,000,000 is making excellent progress in the solution of social problems that have been worrying the older nations of the world for years. Canada has solved many of the pioneer problems in connection with the Yukon, in a manner that has caused some citizens of the United States to prefer residence upon Canadian rather than upon Alaskan soil. The reports of compulsory arbitration from Australia show that such arbitration has been satisfactory and successful there. These are but single instances which should lead us in the United States to consider carefully what the English colonies are doing, for a study of the manner in which they are working out the same industrial problems which confront us would undoubtedly prove of value.

THE UNITED STATES STEEL CORPORATION.

THE articles of incorporation of the United States Steel Corporation have at last been made public. Briefly stated, the objects of this corporation as stated in its charter rights seem to be to do about as it pleases with anything that happens to come its way, particular stress of course being laid upon "the manufacture of iron, steel, manganese, coke, copper, lumber and other material and all or any articles consisting or partly consisting of iron, steel, copper, wood, or other materials, and all or any products thereof." As it can also own land "for any purpose of the company, can mine and remove all minerals and timber, can buy or sell any of the materials mentioned above, or any articles consisting of or partly consisting thereof, and can engage in any other manufacturing, mining, construction, or transportation business of any kind or character whatsoever," there seems to be very little left for the company to acquire, excepting legal authority for preventing competition.

The new corporation is capitalized at \$1,100,000,000, of which \$300,000,000 will be in bonds, \$400,000,000 in preferred stock, and \$400,000,000 in common stock. The capital stock named in the articles of incorporation is \$3,000 with power to increase same. The capital stocks of the Carnegie Co., will be paid for in bonds, while the other companies in the consolidation will receive preferred and common stocks.

OFFER WITHDRAWN.

FOR several months past we have published in *MINES AND MINERALS* an advertisement for copies of former editions of *THE COAL AND METAL MINERS' POCKETBOOK*, of the *MINE FOREMAN'S POCKETBOOK*, and *THE COLLIERY ENGINEER POCKETBOOK*, offering in exchange for these copies of the 6th edition of *THE COAL AND METAL MINERS' POCKETBOOK*. Enough copies of these former editions have been received and this offer is therefore withdrawn.

Watered Stocks.

Mr. Abram S. Hewitt, well known in mining and metallurgical circles has recently written as follows in regard to the much disputed point of "watered stocks."

"The fact is that the water in the stocks of industrial corporations is not only innocuous, but from one point of view is positively advantageous. The modern corporation is usually organized on the basis of preferred stock, representing the fair money cost of the property, and of common stock, representing the good will and the possibility of profit which may be realized out of the business. The common stock, therefore, has cost no money, and it sells in the market at a price which has some relation either to the actual or possible profits after paying a fixed rate of dividend upon the preferred stock, which represents actual investment of money. In this common stock, to my mind, lies the chief hope of the workingman of this country in the future. When times are prosperous it will undoubtedly bring a high price. When times are adverse the stock will fall to a nominal value. It does, however, control at both times the administration of the business. My expectation is that when it is cheap the workmen will buy it up, and in the course of the coming century I expect to see most of the large industrial corporations controlled by the workmen, who have thus secured the ownership of the common stock at a low price and under favorable circumstances.

"When this era is reached, the preferred stock will be in the nature of a loan, on which no dividends will be paid unless the business earns them. In other words, the preferred stock will represent capital, and not debt, and this capital will be at the risk of the business. Common stock, on the other hand, will represent the control of the property, and will very properly find itself in the hands of the executive officers and of the workmen, who actually conduct the business. When times are good the workmen will thus share in the prosperity. When times are bad the capitalist will have to go without his dividends upon the preferred stock. There will be no conflict between capital and labor when this beneficent system shall have developed into the general ownership which I expect to see, as soon as the working classes of this country are sufficiently educated to take advantage of this new and favorable situation.

"I am somewhat surprised that so intelligent a man as Mr. Mitchell has shown himself to be has not already used the funds at his command to secure the control of one of the great coal

companies, some of which are organized on the basis of preferred and common stock above described. I have no doubt that he will sooner or later adopt this policy, and he and his associates will then be able to understand what the difficulties are in conducting large mining operations, and if they be as profitable as he thinks, they will be able to secure these profits for the members of the trades unions which he represents with so much ability."

BOOK REVIEW.

NOTES ON NOME, by Arthur L. Pearse. 10 pages.

WATER-SUPPLY AND IRRIGATION PAPERS OF THE U. S. GEOLOGICAL SURVEY. No. 40. The Austin Dam, by Thomas U. Taylor.

REPORT OF THE MINE INSPECTOR OF NATAL FOR 1899, by C. J. Gray, A. R. S. M., Commissioner of Mines, Pietermaritzberg, Natal.

ANNUAL REPORT OF THE DIRECTOR OF THE MINT, for the year ending Jan. 1900. 533 pages. Treasury Department, Washington, D. C.

MONOGRAPH OF THE U. S. GEOLOGICAL SURVEY, Vol. XXXIX, by T. Wayland Vaughan. The Eocene and Lower Oligocene Coral Fauna.

REPORT OF COMMISSIONER OF PATENTS FOR THE YEAR ENDING DECEMBER 31, 1900. C. H. Duell, Commissioner, Washington, D. C. 19 pages.

PROCEEDINGS OF THE LAKE SUPERIOR MINING INSTITUTE. Sixth Meeting. February, 1900. Vol. VI. F. W. Sperr, Sec., Houghton, Mich. 58 pages.

FATAL ACCIDENTS IN THE MINES OF THE UNITED KINGDOM DURING 1900, by the Secretary of State for the Home Department, London, England.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE (English), No. II, 1900. Vol. LVIII, by Bennett H. Brough, Sec., London, England. 656 pages.

EXPLOSIVE GAS IN A METALLIFEROUS MINE, by F. W. Grey. 5 pages. Paper read before the Institution of Mining and Metallurgy, London, England.

A GRAPHIC METHOD APPLIED TO DELINEATING ORE BODIES WITH NOTES ON SAMPLING AND ESTIMATING ORE RESERVES, by A. G. Charleton, V. P. 23 pages.

A DESCRIPTION OF CERTAIN COAL LANDS IN THE BIG SANDY VALLEY OF EASTERN KENTUCKY. Published by Beckner & Jouett, Winchester, Ky. 55 pages.

THE SOUTHWEST MINERS' ASSOCIATION. J. H. Fountain, Sec., Room 2, German-American Savings Bank, Cor. First and Main Sts., Los Angeles, Cal. 12 pages.

REPORT OF THE COAL MINE INSPECTOR OF THE STATE OF UTAH FOR THE YEARS 1899 AND 1900, SALT LAKE CITY. Gomer Thomas, Coal Mine Inspector. 115 pages.

STATISTICS OF THE MINERAL PRODUCTION OF TEXAS. Compiled by Wm. B. Phillips, Ph. D., Field and Economic Geologist, University of Texas. Pamphlet 15 pages.

AMERICAN INDUSTRIAL EDUCATION. What Shall it Be? Preliminary Report of a Committee of the Society for the Promotion of Engineering Education. H. S. Jacoby, Sec., Ithaca, N. Y. 74 pages.

BULLETIN No. 71. The Consolidation of Country Schools, and the Transporting of the Scholars by Use of Vans, by H. H. Longsdorf, A. M. D., Department of Agriculture, Harrisburg, Pa. 89 pages.

STEAM TURBINES, WITH SPECIAL REFERENCE TO THE WESTINGHOUSE-PARSONS STEAM TURBINE, by Francis Hodgkinson. 42 pages. Reprinted from Proceedings of Engineers' Society of Western Pa.

MINES AND MINING IN THE BLACK HILLS, Published by the Chicago, Burlington, and Quincy R. R., Chicago, Ill. 47 pages. It gives a very interesting description of the several mining districts in the Black Hills, and is well illustrated.

REPORT OF THE COLORADO STATE BUREAU OF MINES, 1899-1900, by Harry A. Lee, Denver, Colorado, Commissioner of Mines. 68 pages. A complete review of this book is found on page 415 of this number in the form of an abstract by Prof. Arthur Lakes.

THE IMPORTANCE OF TOPOGRAPHY IN GEOLOGICAL SURVEYS. Notes on Mine Surveying Instruments. Movements of Ground Water, and a Geological and Topographical Map of the Shippen and Wetherill Tract, Schuylkill Co., Pa., by Benj. Smith Lyman.

MINES AND QUARRIES. General Report and Statistics for 1899. Part IV. Colonial and Foreign Statistics. Statistics relating to persons employed, output, and accidents at mines and quarries in the British Colonies and in foreign countries. C. Le Neve Foster, D. SC., F. R. S., Inspector of Mines, London, England. 457 pages.

PICTORIAL HISTORY OF THE LOCOMOTIVE, compiled by Wm. Wright, published by The Chicago Pneumatic Tool Co., Chicago, Ill. 81 pages. A novel compilation, containing illustrations and descriptions of a large number of types, showing gradual progression and growth from Cugnot's Locomotive built in 1771 to the monster 1899 locomotive.

HISTORY OF THE PORTLAND CEMENT INDUSTRY IN THE U. S., by Robt. W. Lesley. Published by the American Cement Company, Philadelphia, Pa. 146 pages. Although nominally a catalogue this work contains a large amount of useful information in regard to Portland cement which makes it useful for the library of any engineer or person engaged in construction work.

METAL STATISTICS FOR 1900. Published by the Report Company, 61 Beekman St., New York. This report contains well-printed tables showing the daily prices of the principal metals during the year 1900, together with considerable other interesting statistical matter about the metals, which will be of value and interest to all who are following the financial and market side of the metal business.

MINES AND MINERAL STATISTICS OF MICHIGAN, by Jas. Russell, Commissioner of Mineral Statistics, Marquette, Mich. 490 pages. This report contains separate chapters upon iron, copper, charcoal, pig iron, coal, salt, gold, and silver, and the minor minerals of Michigan. Each of these chapters is historical and statistical, and the work contains a large amount of interesting information.

THE CLIPPING FILE. This is a file for classifying and filing newspaper clippings, references to books, magazines, and similar data. It also contains a system of classification, which is copyrighted by J. M. Brown. The file consists of an ordinary cardboard holder which contains ten envelopes numbered and with a printed classification on the back of each. For sale by the Clipping File Co., Cleveland, O. Price \$1.

FIRST AID HAND BOOK. A collection of instructions for rendering effective and intelligent first aid in accidents and sudden illness, by M. J. Shields, M. D. Edited and published by Thos. Boundy, Jermyn, Pa. 93 pages. This little pamphlet will be of interest and great service to any one connected with mines, as it contains a large amount of information useful in cases of accident and injury. It goes very completely into the assistance of those injured, particularly in accidents about the mines. Its author, Dr. Shields, has had wide experience about the coal mines, and has organized a number of First Aid Corps to render assistance in cases of emergency at mines before a physician can be called.

REPORTS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES, Vol. 7, Part 1, published by the Department of Mines and Agriculture, Sydney, N. S. W. 28 pages, illustrated. This volume contains the following papers:—I. The Auriferous Deposits of Lucknow, by E. F. Pittman, A. R. S. M., Government Geologist, with Plate I. II. The Auriferous Ore-beds of the Lyndhurst Gold Fields, by E. F. Pittman, A. R. S. M., Government Geologist, with Plates II-V. III. On a Collection of Graptolites from Mandurama, by T. S. Hall, M. A., Biological School, Melbourne University, with Plate VI. IV. Notes upon the Occurrence of Gold in Volcanic Glass at Grassy Gully, Yalwal District, by J. B. Jaquet, A. R. S. M., Geological Surveyor, with Plate VII. V. Contributions to our knowledge of Broken Hill, by R. Beck, Professor at the School of Mines, Freiberg, with Plate VIII.

COAL, TAR, AND AMMONIA, by Geo. Lunge, Ph. D. Third and enlarged edition. Published by Gurney & Jackson, 1 Paternoster Row, London. Price, \$8.52. 929 pages. The first and second editions of this book are too well known to require comment at this time, and the fact that a third edition is called for is additional proof both of its popularity and value. The author states in the preface to the third edition that this edition has been prepared in conjunction with Dr. Hippolyt Köhler, who has been actively engaged as a distiller of tar on a large scale and who has also been a prolific writer upon this and other scientific subjects. In conjunction with Dr. Köhler the author has been able to bring the book entirely up to date in every respect, and in the translation into English it has apparently not suffered in any way. The book is well printed and copiously illustrated, and should prove of great value to all who are interested in this industry. It is particularly opportune at the present time when so much interest is being paid in this country to by-product coke ovens. The scope of the book is shown by the chapter headings, which are as follows: Introductory; Processes for Obtaining Coal Tar; The Properties of Coal Tar and its Constituents; The Applications of Coal Tar without Distillation; The First Distillation of Coal Tar; Pitch; Anthracite Oil; Creosote Oil; Carbolic Acid and Naphthalene; Light Oil and Crude Naptha; Rectification by Steam; Final Products; Sources from which Ammonia is obtained; The Composition and Analysis of Ammonical Liquor, and Properties of its Constituents; The Working-up of Ammonical Liquor; Other Technically Important Ammonium Salts; Appendix; Addenda.

BULLETINS OF THE U. S. GEOLOGICAL SURVEY. Chas. D. Walcott, Director, Washington, D. C.

- No. 163, Flora of the Montant Formation, by F. H. Knowlton. Price, 15 cents.
 No. 164, Reconnaissance in the Rio Grande Coal Fields of Texas, by T. W. Vaughan. Price, 20 cents.
 No. 165, Contributions to the Geology of Maine, by Henry S. Williams and Herbert E. Gregory. Price, 25 cents.
 No. 166, A Gazetteer of Utah, by Henry Gannett. Price, 15 cents.
 No. 167, Contributions to Chemistry and Mineralogy from the Laboratory of the U. S. Geological Survey, by Frank W. Clarke. Price, 15 cents.
 No. 168, Analyses of Rocks, Laboratory of the U. S. Geological Survey, 1880 to 1899, by F. W. Clarke. Price, 20 cents.
 No. 169, Altitudes in Alaska, by Henry Gannett. Price, 5 cents.
 No. 170, Survey of the Boundary Line Between Idaho and Montana from the International Boundary to the crest of the Bitterroot Mountains, by R. U. Goode. Price, 15 cents.
 No. 171, Boundaries of the U. S. and Territories, with Outline of History of Important Changes (second edition), by Henry Gannett. Price, 30 cents.
 No. 172, Bibliography and Index of North American Geology, Paleontology, Petrology and Mineralogy for 1899, by F. B. Weeks. Price, 15 cents.
 No. 173, Synopsis of American Fossil Bryozoa, by John M. Nickles and Ray S. Bassler. Price, 40 cents.
 No. 174, Survey of the Northwestern Boundary of the U. S., 1857-1861, by Marcus Baker. Price, 10 cents.
 No. 175, Triangulation and Spirit Leveling in Indian Territory, by C. H. Fitch. Price, 10 cents.
 No. 176, Some Principles and Methods of Rock Analysis, by W. F. Hillebrand. Price, 15 cents.

THE CHEMISTS' POCKET MANUAL, a practical handbook containing tables, formulas, calculations, physical and analytical methods for the use of chemists, assayers, metallurgists, manufacturers, and students, by Richard K. Meade, B. S., Instructor in Chemistry in Lafayette College, Easton, Pa. The Chemical Publishing Co., Easton, Pa. Price, \$2.

While the title of this book is broad, its contents are to a certain extent limited and somewhat disappointing. It comprises a number of tables and a brief description of qualitative and quantitative analytic schemes. The tables are well arranged and certainly useful to the working chemist and the student, but they do not come up to the standard of other similar pocketbooks. The quantitative part of the book is rather short. Fifteen pages are given to the analysis of iron and steel and to all the other industries only about twenty-three pages. Nothing is said about the analysis of gases, and such important industries as the manufacture of sugar, tanning, etc., are entirely left out. Exact data in regard to the chemical and physical examination of cement, for which in the last few years there has been such a great demand, are missing.

In the scheme for the analysis of coal the determination of volatile combustible matter of anthracite and coke is given according to Mr. Meade's investigations, which are published in the Journal of the American Chemical Society, Vol. XXI, Part 12, and neither the report of the Committee on Coal Analysis of the American Chemical Society published at the same time nor the general practice has been taken into account. While Mr. Meade's investigations may be very valuable and his method of determining the volatile combustible matter entirely correct, his method has not been adopted by the Committee on Coal Analysis and is not the one generally in use in the anthracite coal region, or in the laboratories of large coal consumers. It is certainly to be regretted that, in a book which is supposed to serve for general references, the method of the author should have preference to that in general use. A preference like that is exactly what creates such mistakes as led Mr. Meade to his investigations. D.

ENGINEERING CHEMISTRY. A manual of quantitative chemical analysis for the use of students, chemists, and engineers. Second edition. Thomas B. Stillman, M. Sc., Ph. D., Professor of Analytical Chemistry in the Stevens Institute of Technology. The Chemical Publishing Co., Easton, Pa. Price \$4.50.

This book appears before us as an old friend in new garb with Eastertide. The recent second edition sustains the reputation of the first edition in containing a large amount of valuable information. It has been rearranged, and as the author says in the preface, special attention has been given to the article upon gas analysis, blast-furnace practice, the heating value of fuels, the purification of water for technical purposes, lubrication, car illumination, and the examination of Portland cement. The book certainly cannot be recommended too highly to all those who are interested in manufacturing and engineering chemistry. D.

NOTE BOOKS RECEIVED.

THE PHILIP CAREY MFG. CO., Lockland, O.
 THE VINTON COLLIERY CO., No. 1 Broadway, New York.

New Uses for Aluminum.

Owing to the marked increase in the price of copper during the year the field for the utilization of aluminum has been greatly expanded. Successful experiments have been made during the year in the use of aluminum, both pure and alloyed with copper, for electrical conductors. The weight of a wire of pure aluminum is 48 per cent. of the weight of a copper wire of equal conductivity. Hence the price of aluminum per pound might be a little more than twice that of copper and still the cost of the conductors for a given amount of electrical power would be the same if constructed of either metal. The price of aluminum, however, is only a little over 50 per cent. greater per pound than that of copper. Aluminum, therefore, is considerably less expensive than copper for this purpose. The first actual application of the metal on a large scale for this purpose has been made during the year by the Chicago and Northwestern Elevated Road. Twenty miles of 1½-inch cables, weighing 150,000 pounds, have been put in place to distribute the motive power to the trolley cars of the new road.

Another important use for the metal is as a reducing agent in the preparation of the metals from such refractory materials as the oxides of chromium, titanium, tungsten, vanadium, molybdenum, etc. The finely powdered aluminum is intimately mixed with these metallic oxides in a refractory crucible and enough barium peroxide is added to start the reaction. The mixture is readily ignited, and the extremely active oxidation of the powdered aluminum reduces the oxides of the other metals present. The use of metals prepared in this way for combination with steel has been found very much more satisfactory than when the various alloys with iron are employed. The powdered metal is also coming into use for the production of flash lights for photography, replacing magnesium for this purpose. It is also extensively used as a paint, being simply mixed with a varnish like ordinary bronzing powders.

The field of investigation of the various alloys of aluminum is a wide one, and considerable attention has been given to it in the past year. A new alloy of aluminum and magnesium, called magnalium, has been prepared, containing from 75 to 90 per cent. of the former metal with 10 to 25 per cent. of the latter. The color of the resulting metal ranges from tin-white through blue-white to brass-yellow, as the proportion of magnesium increases. Since the latter metal is 40 per cent. lighter in weight than aluminum, the alloy is also of less specific gravity. It is harder than aluminum, will take a fine polish, is unalterable in the air, and can be worked as readily as brass.

These are merely a few of the more important recent additions to the use of the metal in the arts. A complete list of the uses to which it has been successfully applied would be a very long one. The price of the metal will doubtless continue to decrease as the various processes in its preparation are improved, and particularly when the expiration of the present patent permits free competition in its production. Even at the present price it is considerably cheaper, bulk for bulk, than copper or brass, and if the supply were sufficient to meet the growing demand, its uses would increase even more rapidly than they have done.—U. S. Geological Survey.

The Edgar Zinc Company, Cherryvale Plant.

This plant is situated in the town of Cherryvale, Montgomery County, Kansas, about seventy miles from the Joplin Zinc Ore District. Three railroads run through the town; the St. Louis & San Francisco; the Atchison, Topeka & Santa Fe and the Kansas City, Ft. Scott & Memphis. Numerous switches and sidings connect with the works. These roads give direct transportation throughout the United States, including a short line to the coast.

The plant consists of thirty smelting furnaces of one hundred retorts each, with roasting kilns and pottery buildings, with most modern equipment for the manufacture of retorts; tiles, blocks, &c.; carpenter-shop; blacksmith-shop; power machine shop, with gas fitting equipment, all buildings being of the most substantial kind. The plant is modern in every particular, being fitted out with labor-saving devices in every department, the fuel for the entire works, the smelting, roasting and power, being derived from natural gas entirely. The corporation has laid about ten miles of pipe and has twelve flowing gas-wells. The plant is entirely new, having been completed in December, 1899, and has a capacity output of 13,500 tons of spelter annually and consumes some thirty-two thousand tons of zinc ores annually, which are mined in the Joplin District.

A large number of dwelling houses for operatives have been constructed. These houses are neatly finished and painted; contain four rooms with cemented cistern and city hydrant water and equipped with gas for lighting, heating and cooking. They are well protected against fire, having city fire plugs located throughout the works, with hose and fire apparatus department.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The editor is not responsible for views expressed by correspondents in this Department.

Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Miscellaneous Questions.

Editor Mines and Minerals:

SIR:—I would thank you for inserting in the correspondence column of MINES AND MINERALS the following questions:

No. 1.—Locomotive and train weighing 300 tons, traveling at the rate of 30 miles an hour, going round a curve with a radius of 6 chains, what is the friction on the flanges of the wheels?

No. 2.—A man 10 stone in weight, falls down a shaft 200 fathoms, with what force will he strike the bottom?

Yours truly,
Cornsay Colliery, Durham, Eng. FRANK CRAGGS.

Arrangement of Shaft Bottom.

Editor Mines and Minerals:

SIR:—I have been looking up the subject of Shaft Bottoms in MINES AND MINERALS, and while I found several very neat schemes I failed to find just what I wanted.

Given a seam 7 ft. thick 400 ft., below surface pitching west 5%, no property lines, surface tracks can run in any direction, surface pitching 10% west, to open a two compartment hoisting shaft, wagons weighing one ton, holding two tons of coal, output desired 2,000 tons in ten hours.

It is desired to do all the caging from one side, and to use electric motors for hauling. We can put shaft above or below tracks. Kindly suggest a scheme. Yours truly,
Thomas, W. Va. JOHN F. HEALY.

Capacity of Exhaust Pipe.

Editor Mines and Minerals:

SIR:—In reply to question of J. F. H., relative to the capacity of a 12-inch exhaust steam pipe, published in your January issue, would say it would be a difficult matter to state positively whether this line would have a sufficient capacity to allow of the two extra engines exhausting into it without more data. The rule in common use in practice is to determine the amount of steam the engine is using, and estimate the area of the section of the exhaust pipe using a velocity not exceeding 6,000 feet per minute for the exhaust steam. The first two engines mentioned are probably using from 35 to 40 pounds of steam per horsepower per hour. Assuming that these engines use, say 35 pounds of steam per horsepower per hour, we have, $35(350 \div 230) = 340$ pounds of

steam per minute exhausting from these two engines alone. The gauge pressure upon this exhaust steam should not exceed one or two pounds, making the absolute pressure say 17 pounds per square inch. At this pressure the volume of one pound of steam is 22.98 cubic feet, and $22.98 \times 340 = 7,813$ cubic feet of exhaust steam per minute. The capacity of a 12-inch steam pipe at a velocity of 6,000 feet per minute is 4,712 cu. ft. per min., a capacity that would only properly accommodate 350 horsepower. If more steam is exhausted into this line the back pressure will impair the efficiency of the engines. This effect will be the greater as the exhaust pipe is longer, due to the increased friction of the exhaust steam passing through the pipe. Yours, etc.,
J. T. B.

The Best Arrangement for an Escapeway.

Editor Mines and Minerals:

SIR:—The discussion often arises amongst miners as to the best form and manner of equipping the escape shaft at a mine, with respect to safety and speedy ascent for the employees in the mine, in case they all had to come out that way in the shortest possible time. Some say the escape shaft equipped with cage and hoisting engine is best, safest, and speediest means for getting the employees to the surface; others that the shaft equipped with ladders and hand railing set at 45° angle is best; while still others say that the best escapeway in connection with a vertical opening is a manway, driven across the measures at an angle of 45°, and equipped with a continuous ladder and hand railing from top to bottom. Take as an illustration the following example: A mine has an escape shaft 350 feet deep, 5 × 8 feet in the clear. It is

equipped with cage and hoisting engine; 600 persons are employed underground. (a) In about what time could they all be hoisted out with safety not to overcrowd the cage? (b) In about what time could they all come out if it was equipped with proper ladders and hand railing set at 45° angle. (c) If it was a slope escapeway and equipped as already stated in about what time could the men all come out? In either case the employees are all at the bottom together and the sectional area of either opening the same, but the slope is 5 feet high and 8 feet wide with the hand railing on each side. (d) Which of these forms would be the cheapest to construct and maintain, and which the most reliable escapeway? Yours, etc.,
R. J. PICKETT,

Spring Valley, Ill.

Compressed Air Losses.

Editor Mines and Minerals:

SIR:—What is the loss in output of an air compressor at an altitude of 5,000 feet? Yours, etc., X.

Fifteen per cent.; that is, the output at 5,000 feet, is 85 % of that at sea level. [See Coal and Metal Miners' Pocketbook, page 195, for complete table.]

Acetylene Gas for Mine Illumination.

Editor Mines and Minerals:

SIR:—I have been waiting patiently for some correspondent through your journal to take up the subject of acetylene gas, for lighting in mines. It is surely one of the coming lights. I have been using this form of light for engineering purposes in mines for some time with entire satisfaction, and cannot understand why it does not become more popular. It is true that a form of lamp for burning this gas has not yet been perfected suitable for miners, but efforts are now being made to this end, and I understand with assured success. The lamps are now being made in forms very suitable for engineers and mine officials. At the present price of carbide this light can be produced cheaper than with oil, and no grease to contend with. A lamp that will burn eight hours at a cost of four cents (as used in the quarries of Ulster County, N. Y.), and make a light superior to ten miners' lamps is a great satisfaction. The lamp used for engineering burns four hours with one filling at a cost of two cents. I will say no more on the subject at this time but invite correspondence through this journal or personally, pro and con. Respectfully,
Barnum, W. Va. M. MASTELLER, E. M.

Modulus of Elasticity of Wire Ropes.

Editor Mines and Minerals:

SIR:—In the March, 1900, issue of MINES AND MINERALS is a very excellent article on Hoisting Rope by Robert Peele. Information is given on the bending of steel rope about pulleys or sheaves, for ordinary crucible steel wire having a modulus of elasticity of 29,000,000. There are two additional grades of steel now in the market, viz.: extra crucible and plough steel. Have you any reliable data to furnish moduli of elasticity for these grades or other grades of specified tensile strength? Yours truly,
Chicago, Ill. C. H. FITCH.

Messrs. John A. Roebling Sons' Co., of Trenton, N. J., have answered this query as follows: "The modulus of elasticity for crucible steel wire varies from 27,000,000 to 29,000,000, and for plough steel wire from 28,000,000 to 31,000,000."

The Hazard Manufacturing Co., of Wilkes-Barre, Pa., has also kindly furnished the following information:

"The modulus of elasticity of the crucible steel varies between 28,000,000 and 32,000,000. It rarely falls below 28,000,000 or exceeds 31,000,000. It is generally taken at 30,000,000.

"For the plough steel, the modulus has a lesser range, but rarely goes above 32,000,000. It may be safely taken at 32,000,000.

"Modulus of elasticity means the ratio of the pull in pounds per square inch of cross-section, to the extension per inch of length of the test piece, when tension is applied. The load, however, must be measured within the elastic limit of the piece under test; otherwise the result will not necessarily be the modulus."

Pressure Blower for Culm or Grain.

Editor Mines and Minerals:

SIR:—Can you give me any information in regard to conveying grain, coal slack, or iron ore pneumatically? What size of pipe would be required, and how much air, and what pressure and power would be necessary to convey 50 tons of coal slack per hour, a distance of 200 feet horizontally? Also please state what pressure and power would be required if the pipe was inclined upward 30°. Yours, etc.,
Allegheny, Pa. R. K.

An ordinary Root or Sturtevant blower is generally used for this purpose. The weight of material to be handled per minute divided by the weight of 1 cubic foot of air will give the volume

of air required per minute. It is customary in the handling of the heavier materials such as fine coal slack or iron ore ground fine, to employ a smaller diameter of pipe than is used in the conveyance of grain. To determine the size of pipe required, the volume of air (cu. ft. per min.) is divided by the velocity of the air (ft. per min.), which gives the area of the cross-section of the pipe in square feet. For grain a velocity of 6,000 feet per minute is used, while for coal slack and fine coal a velocity of 12,000 feet per minute is usually employed. Having determined the quantity of air and size of pipe required, its length being given, the pressure is determined by the formula:

$$p_1 = .00015 \frac{lq^2}{d^5},$$

in which p_1 = pressure required (oz. per sq. in.),
 q = quantity of air (cu. ft. per min.),
 l = length of pipe (ft.),
 d = diameter of pipe (in.).

The above formula applies to horizontal pipes only. When the pipe is inclined the vertical height must be calculated and the pressure due to this height is then found by the formula:

$$p_2 = .0035 h.$$

in which p_2 = pressure due to head (oz. per sq. in.),
 h = vertical height (ft.).

In determining the horsepower required to operate the system we must reduce the pressure (oz. per sq. in.) to its equivalent pressure (lb. per sq. ft.). Pressure blowers are always rated upon a basis of ounces per square inch, while the horsepower of a current is based upon a pressure of pounds per square foot. To reduce the former to the latter we multiply by $\frac{144}{16} = 9$. The

horsepower to operate the system is determined by the formula:

$$H = \frac{qp}{33,000} \times 9,$$

in which H = required horsepower,
 p = pressure producing circulation (oz. per sq. in.).

The conveyance of 50 tons of coal slack per hour would require a volume of air equal to $\frac{50 \times 2,000}{60 \times .0766} =$, say 21,000 cu. ft. per min.

The sectional area of the pipe will, therefore, be $\frac{21,000}{12,000} \times 144 = 252$ sq. in. The diameter of this pipe is $\sqrt{\frac{252}{.7854}} =$, say 18 in.

The pipe being horizontal the pressure required will be

$$p_1 = .00015 \frac{200 \times 21,000^2}{18^5} = 7 \text{ oz. per sq. in.}$$

When this pipe (200 ft. long) is inclined at an angle of 30°, the vertical height will be $200 \times \sin. 30 = 200 \times .5 = 100$ ft.; and the pressure due to this head is

$$p_2 = .0035 \times 100 = .35 \text{ oz. per sq. in.},$$

making the total pressure for the inclined pipe $7 + .35 = 7.35$ oz. per sq. in. The horsepower in each of these two cases will then be

$$H = \frac{21,000 \times 7}{33,000} \times 9 = 40.9 \text{ horsepower (horizontal pipe).}$$

$$H = \frac{21,000 \times 7.35}{33,000} \times 9 = \text{say } 45.0 \text{ horsepower (inclined pipe).}$$

The practice of conveying culm by means of a blower has been very largely abandoned both in the Pennsylvania region and also in the West. There are a few of these blowers still in use. The claim is made that when the pipe can be made horizontal, and discharges into a hollow below the level of the pipe the arrangement works satisfactorily, but when the pipe pitches upward and the discharge must be made under a head of 75 to 90 feet the working of the system has not proven as uniformly satisfactory. One of the principal objections to this system of conveying culm, however, arises from the fact that the larger pieces of the discharged material are thrown farther from the mouth of the pipe, while the smaller pieces and the fine dust accumulate close to the point of discharge. This gives a very uneven distribution to the discharged material and causes the accumulation in one place of a large quantity of very fine dust. The result is that this fine material becoming wet generates heat and fires the culm readily. Another objection is that a high wind will carry the finer portion of the discharged material a long distance, which has proven a nuisance in many instances. It is claimed also that the system does not work satisfactorily at all times, and that there is a tendency to clogging in the pipe. This is largely due to a lack of uniformity in the flow of the air and of the material. The conditions are such in an inclined pipe pitching upwards that the material tends to accumulate and clog the pipe when the slightest obstruction is encountered, owing to the loss of the momentum in the material. All of these objections have been urged against the system.

J. T. B.

The Santa Fe Mining District, Nevada.

This district located in the Monte-Christo Range of mountains, Esmeralda County, is reached by the Carson & Colorado Railroad, a branch of the Southern Pacific System. In common with the remainder of the western portion of the Great Basin in which it lies, this district and adjacent region exhibits the usual succession of wide flat valleys and isolated ranges, alike characterized by the forbidding sterility of the desert. The valleys or flats, covered with deposits of salt, borax, etc., demonstrate their recent emergence from the condition of lake bottoms. The evaporation of the waters of these lakes, all of which by concentration became intensely saline in character, has left deposits of useful material of some magnitude and value. The range in which the Santa Fe district is situated lies in a generally northerly and southerly direction. It is a result of the great convulsions to which the basin section has been submitted. Prior to the completion of the Paleozoic epoch violent upheavals took place, breaking the enormously thick strata of limestone and thrusting the resulting fractured portions apart, resulting in the formation of the range in its primitive condition. This tilting and fracturing process proceeded along an axis determined by the general direction of the range, north and south, this being the general direction which characterizes the basin ranges. The lacustrine deposits on the ridges and the fossiliferous remains of Paleozoic time, abundant in the limestone formation, easily determine the period in which these mountains were raised up from the bottom of the Paleozoic sea. The volcanic activity was accompanied by the usual outpouring of eruptive substance evidenced by the occasional dikes of porphyry and intrusions of granite encountered, together with some lava. Great masses of hematite, giving every indication of plutonic origin, or of having been subjected to volcanic heat, protrude at various points, their hardness and chemical composition preserving them from the changes to which the softer country rock has been subjected. Erosion has played some part in the formation and the absence of vegetation enables the observer to see at a glance the source of the debris or wash which covers the lower flanks of the mountains.

At a period subsequent to the Paleozoic, but not easily arrived at, began the formation of the mineral deposits, which at least on the surface, are so abundant. It is probable that the deep underground circulation of this section proceeded by percolation from the bottom of the lakes through these fissures formed during the volcanic activity. These waters heated in their course returned again towards the surface charged with various mineral-forming constituents, following the bedding planes and crevices, and according to the commonly accepted theory deposited their values in the cooler zone above. The ore lies along, in and between the fissures as infiltrated bodies more or less lenticular, but occasionally as irregular impregnations in the outlying rocks. At other points where the porphyry intrusions are found in the limestone, strong mineralization is present, evidently due to the impermeability of the eruptive rock. During the process of metamorphism following the intrusion of eruptive rocks, the magnesia of the dolomite has been converted into a silicate and as such has risen through the fissures and forms a talcose coating on the sides.

The usual oxidizing and hydrating action of surface waters percolating downward, effected the change in character of the ore from sulphide to carbonate and oxide, this oxidizing action being known to have continued to a depth of 300 feet, this being the limit of the exploration work thus far accomplished, and it is reasonable to assume that owing to the extensive movement and resultant shattering of the upper limestone, no continuous bodies of ore will be encountered until at greater depth the firm formation is reached.

Some additional evidence in support of this view of the origin of these mineral deposits is furnished by the existence of extinct geysers at various points in juxtaposition with the veins or deposits themselves. One in particular with its well rounded orifice lined with crystals of gypsum has in its immediate neighborhood well defined veins of cupriferous mineral which appear to have been formed by a process identical in character with that which resulted in the formation and deposition of the gypsum.

The chief value of these deposits so far as exploited is in their copper and silver, the former ores ranging from chrysocolla and malachite to chalcopryrite, chalcocite and cuprite, the silver ores being argentite, and stephanite.

From the abundance of the croppings as well as from the probable origin of the deposits, the exploration of this section should result in the uncovering of mineral wealth of great extent.

E. McCORMICK,

Luning, Nevada.

It is reported that the American Bridge Company will build a mammoth plant in Pittsburg, where it will have the advantages of securing its raw product under the most favorable circumstances.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to *MINES AND MINERALS*.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to *MINES AND MINERALS*.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to *MINES AND MINERALS*.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes, and to mention the numbers of the questions when so doing.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for April.

Ques. 668.—*Working an Ore Chimney.*—Describe how you would work a nearly vertical ore chimney extending downward from the surface. The ore is an extremely high-grade mineral, which makes its complete extraction essential. The country rock of the adjoining strata is not wholly selfsupporting; it does not crumble but has a tendency to break in large pieces. The ore chimney is elliptical in cross-section, its smaller diameter averaging 18 feet while the larger diameter will average 30 feet. Describe particularly the methods of extraction and timbering that will render the working of this ore body safe, and will permit of the entire extraction of the mineral.

Ques. 669.—*Sinking Through Swelling Ground.*—Describe how you would timber a shaft, in sinking through strata that swell, in order to avoid future trouble and annoyance in the operation of the mine.

Ques. 670.—*Direction of Driving Gangways and Rooms in an Inclined Seam.*—A seam of coal has a uniform easterly dip of 10°. The strike of the seam is N 15° 30' W, or S 15° 30' E; the cleats of the coal are not so pronounced as to affect the direction in which the rooms should be driven. Give the direction of the main slope and the gangways or haulage roads, and the direction of the rooms that would afford the most economical handling of the coal from the face to the shaft bottom.

Ques. 671.—*Ventilation Deranged.*—If the ventilation of a mine has been deranged by the accidental setting open of a door, explain why the fire boss should not make the regular inspection of the workings until the ventilation has been restored; and how he should then proceed.

Ques. 672.—*Surveying for Mine Opening.*—A coal seam outcropping on a side hill has a dip of 3°, the direction of the dip being N 80° 30' E. This seam was formerly worked from a drift driven in upon the seam from the outcrop, the direction of the drift being N 75° 20' W. At a point farther around the hill from the drift opening there is a favorable location for the tippie and side tracks necessary for a large mine; and it is proposed at this point to drive a rock slope having an inclination of 20°, in a direction corresponding to the strike of the seam or S 9° 30' E. In order to make this opening as rapidly as possible the work is to be pushed from both ends, and it is therefore desired to know the point along the drift, at which a level road should be started, in order to meet the foot of the slope where the latter strikes the seam. To determine this the following survey was made from the mouth of the proposed opening around the hill to the mouth of the old drift.

(a) Determine the distance from mouth of drift (Sta. 6) to center line of level road running to meet the slope. (b) Determine the length of the level road from the center line of the drift

to the foot of the slope. (c) Determine the length of the slope from station 1, to its foot where it meets the level road.

Sta.	Deflection Angle.	Vertical Angle.	Distance (feet).	Sta.	Remarks.
1		— 15° 30'	840	2	{ Sta. 1 at Mouth of slope.
2	R 24° 30'	— 15° 20'	400	3	
3	R 40° 25'	— 9° 30'	250	4	
4	L 62° 30'	+ 5° 00'	190	5	
5	R 85° 20'	+ 10° 20'	560	6	{ Sta. 6 at Mouth of drift; Foresight on line of drift.
6	R 123° 20'				

Ques. 673.—*Spontaneous Combustion as Causing Gob Fires.*—Explain as clearly and concisely as possible the conditions and reactions that cause spontaneous combustion in the gob and waste places of a mine, and result in gob fires.

Ques. 674.—*Steel vs. Wooden Mine Cars.*—What are the advantages and disadvantages of using steel mine cars instead of wooden ones?

Ques. 675.—*Size of Exhaust Steam Line.*—(a) Calculate the size of an exhaust steam line having a 125-horsepower haulage engine (duplex), the exhaust from the engine being carried into a feedwater heater in the boiler room. (b) What should be the size of the steam pipe supplying steam to this engine.

Answers to Questions Which Appeared in the February and Previous Numbers and for Which Prizes Have Been Awarded.

Ques. 638.—*Gob Fires in Abandoned Workings.*—The mine of which I have charge is troubled with gob fires in the abandoned workings near the shaft bottom. The fire walls and brick stoppings which we have used to close off these abandoned workings are only partially effective, and owing to shaly roof and porous character of the coal, sufficient air is still supplied to these abandoned workings to render the fire a constant menace to the mine. The mine is worked on the room-and-pillar system, with double entries, and is ventilated by means of an exhaust fan. Will you kindly suggest what, in your opinion, would be the most effectual manner of treating this fire, both with respect to the present and future welfare of the mine?

Ans.—Reverse the fan and force the air into the mine. [The mine will then be ventilated under a pressure greater than that of the atmosphere. As a result the mine air, low in oxygen, will be fed upon the fire instead of fresh air; and the gases from the fire will be thrown out instead of being drawn into the mine as formerly under the depression of the exhaust system.] Put down bore holes from the surface directly over the seat of the fire and a few feet back of the fire walls or stoppings, and flush with water and sand. If sand is not available earth will do. The walls and stoppings should be well braced, and means provided for the removal of the water, either by pumping or ditching, before the flushing is done. OSCAR CARTLIDGE, Gillespie, Ill.

Second Prize.—JOHN VERNER, Oskaloosa, Iowa.

Ques. 652.—*Work of a Mule; Maximum Grades in Mule Haulage.*—State what you would consider as the proper work of an average mine mule, in ton-miles per hour, in a flat seam. State what you would consider to be the limit or maximum up-grade in mule haulage; also the maximum down-grade where sprags may be safely used.

Ans.—The work of an average draft horse is stated to be, on an ordinary wagon road, 10 to 20 ton-miles in 10 hours, and the work of a mule one-half of this. Prof. Ihlseng gives the work of mine mules for level roads as varying from 30 to 80 gross-ton-miles in 8 hours; or the work of an average mine mule for the same time as 40 to 50 ton-miles (5 to 6 ton-miles per hour), with a limiting grade of 3 per cent. Hughes gives examples of 3 to 16 ton-miles per hour on level roads. Aside from the question of grades, condition of track and cars, kind and size of wheels, etc., the most important point and one that practically determines the work that a mine mule can do in a day, is the average length of haul. This is evident when we consider the large part of the working time which is lost in changing or waiting for trips. From personal experience, I would consider from 4 to 6 ton-miles per hour as being a good average for the work of an ordinary mine mule, in a flat seam, under the usual mine conditions, increasing slightly with the length of haul. I would consider a grade of from 3 to 4 per cent. the limiting up-grade for mule haulage, depending upon the load hauled. As loaded mine cars will slide on iron rails, with four sprags, on a grade varying from 6 to 8 per cent., the safe down-grade for mule haulage would be something less than this, depending on the condition of track and cars.

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—HUGH CAIRNS, Elco, Pa.

QUES. 656.—*Form and Number of Fan Blades.*—What in your experience is the best form of fan blade for closed fans? State what determines the number of blades to be used in a fan.

[No answers were received to this important question, which still remains open. We hope it will receive attention as it calls for the expression of opinion based upon experience.—EDITOR.]

QUES. 657.—*Calculation of Size of Fan Required for a Given Circulation.*—What size of fan would you employ for the circulation of a volume of 150,000 cubic feet of air per minute against a water gauge of 2 inches?

[In answer to the above question we have received answers giving numerous different types and sizes of fans to be employed. These sizes vary from 16 to 30 feet in diameter, and from 5 to 10 feet in width. Strange as it may seem, those answers giving the closest results are based on practical judgment, no method of calculation being given. Such an answer however correct would not be acceptable as the question is intended to show the method of calculation. All of the dimensions must be given including the form of casing, etc.—EDITOR.]

QUES. 659.—*Form and Dimensions of Coke Ovens.*—Make a sketch showing the best form of coke ovens, and giving the important dimensions of the same.

[This is an important question and one of growing interest in many mining districts, and we hope it will not continue to be neglected. The question is still open.—EDITOR.]

QUES. 653.—*Size of Hoisting Shaft.*—State what factors determine the size of a hoisting shaft for a coal mine. What size of shaft would you adopt for the working of a coal seam lying 300 feet below the surface? The seam is 5' 6" thick, and has a good roof and bottom. Assume the output of the mine to be 1,200 tons per day of 10 hours.

ANS.—The factors that determine the size of hoisting shaft to be adopted for a coal mine are: (1) The maximum output per hour, (2) The depth of hoist, (3) The thickness of the seam [and nature of the roof, floor, and coal, as determining], the size and capacity of the mine cars.

The length of each hoistway, or the width of the shaft in feet, equals the output per hour in pounds, times the depth of the shaft in feet, divided by the continued product of the hoisting speed in feet per hour, the weight of 1 cubic foot of loose broken coal in pounds, and the square feet of cross section of the car, plus the clearance.

Using the factors given in the question, the output is $1,200 \times 2,000 = 2,400,000$ lb. per hour, depth of shaft 300 feet; and

assuming a hoisting speed of 24,000 feet per hour, including stops and delays, and the weight of loose, broken coal as 50 pounds per cubic foot, the average inside width of the car being 4 feet and its average depth 3 feet, we have for the length of hoistway or width of shaft, allowing 12 inches for bumpers and clearance at each end of the car or 2 feet in all, width of shaft = $\frac{2,400,000 \times 300}{24,000 \times 50 \times 3 \times 4} + 2 = 7$ ft.

The width of one hoistway, in the clear between buntings or shaft lining, is found by adding to the width of the top of the car, say 5 feet, 12 inches for clearance and guides, on each side, making $5 + 2 = 7$ ft., making the total width of the compartment 7 feet in the clear. To find the entire length of the shaft in the clear, allowing for a pump, and manway 6 feet wide, there being two hoistways, double the width found above for one hoistway, and add to this the width of the pumpway and the width of two lines of buntions or partitions. In this case, using 6-inch buntions, the entire length of the shaft in the clear will be:

$$\text{Length of shaft} = 2 \times 7 + 6 + 2 \left(\frac{6}{12} \right) = 21 \text{ ft.}$$

The size of this shaft in the clear would therefore be 7×21 feet.

J. F. ELLIOTT, Brookwood, Ala.

Second Prize.—JOHN MCCLANE, Whitney, Pa.

QUES. 654.—*Retarding Conveyers.*—Explain the use and adaptation of retarding conveyers, and what advantages they possess over chutes in the handling of coal.

ANS.—Retarding conveyers are used to lower coal or other material slowly and gently down an incline where, if free to move, they would descend quickly and with more or less breakage. These conveyers consist of some form of link-belt chain or sometimes wire rope provided with flights at regular intervals, the whole moving in a suitable chute or trough conforming to the shape of the flights. The chain may be provided with axles and wheels running on railways, to carry the weight of the conveyer; and the chain passes over sprocket wheels at the top and bottom. The idle side of the chain when not provided with axles and wheels is carried on sprockets stationed at regular intervals along the incline. The conveyers are moved either by the weight of the material sliding in the trough, or by some mechanical device and their motion is controlled with a brake wheel and brake on the

head shaft at the top of the incline. A small engine or other motor is usually required to start the system. Retarding conveyers are advantageous where the coal is fragile or tender and where breakage is undesirable; or in cases where, even though the coal may be hard, a steep or long chute for the coal is a necessity.

This principle is also applied to the lowering of cars down an incline, there being no trough in this case, the cars taking the place of the flights. The chain runs in suitable slides or guides in the center of the two tracks, and is provided with dogs or teeth at regular intervals, which engage the car axles. This system is usually employed to lower loaded cars, their weight sufficing to raise the empty ones upon the principle of a gravity plane; or with the addition of mechanical power, the system is sometimes reversed, raising loads and lowering empties.

CHAS. E. BOWRON, Birmingham, Ala.

[For a description of a retarding conveyer in use at Matewan, W. Va., see MINES AND MINERALS, October, 1899, page 123.—EDITOR.]

QUES. 655.—*Construction of a Dam for Reservoir.*—Describe the construction of a dam across a small ravine, to form a reservoir or water supply for a mine, where the substratum is a sandy loam.

ANS.—To construct a dam across a small ravine, for a reservoir under the conditions named in the question, the water must first be diverted to one side of the ravine, so as to leave a portion of the bed dry. A trench is then excavated on the center line of the proposed dam where the bed is dry, and carried down to a solid impervious stratum. This trench should be from 4 to 6 feet wide and is filled with puddled clay well rammed. The surface soil having been cleaned away to a sufficient depth on each side of this puddled wall or trench, the upper and lower faces of the dam are constructed simultaneously with the puddled center by widening out at this point so as to provide a base that will admit of a slope of 3:1 on the upper, and 2:1 or 2½:1 on the lower side of the dam, and still leave a width of at least 10 feet on top of the dam. Discharge pipes may be laid [if necessary] through the dam and provided with gates or valves just below the puddled wall. The upper slope of the dam should be planked or covered with stone [rip-rapped] to protect it from wash. A waste weir and overflow channel should be constructed, at one side and lower than the top of dam, of such size as will readily carry off the water of a freshet and prevent the overflow of the dam. The weir should be provided with a suitable apron to prevent erosion.

C. D. WRAY, Lillooet, B. C., Can.

Second Prize.—HUGH CAIRNS, Elco, Pa.

[In this soil and for the purposes of a mine supply reservoir, it might be preferable to drive simply a double row of sheath-piling across the ravine, after excavating the surface soil, and make these the center line and support of a good solid clay dam, put in with drags or slushers, which pack the embankment more firmly while it is being built. The clay for the dam might have to be transported from another locality.—EDITOR.]

QUES. 658.—*Adoption of a Haulage System.*—What factors should be considered in the adoption of any kind of mine haulage? State also the conditions that would lead you to adopt electric haulage, and give the advantages and disadvantages of this system of haulage.

ANS.—The factors to be considered in the selection of a system of mine haulage are (1) The length, grades, and curves of the proposed haulage road; (2) The width of haulage entries, character of roof and floor, and the size of mine cars; (3) The output desired, and from what points in the mine it is to be hauled; (4) The probable future extensions of the haulage system; (5) The use of the same power for purposes other than haulage; (6) The general mine conditions with respect to the presence of water and gas, character of coal, height of roadways, etc. After a careful consideration of the above factors and the adaptability of the various kinds of haulage, the final selection should be made with several other factors in view; as for example, (7) The cost of installation of the entire system including the power plant; (8) The relative cost of operation [including repairs and renewals]; (9) The probable life of the mine or the tonnage for which the system is installed.

I would favorably consider electric haulage in mines comparatively free from gas and where the haulage was long and crooked with many grades and only a single track; where there were many gathering points, or where haulage districts were desirable; where the top was fairly good and the bottom would permit a well ballasted track to be maintained; where a flexible haulage system was desired that could be easily extended or modified; especially where power could be used for other purposes as cutting, drilling, etc.; where power could be cheaply generated by waterfalls, etc.; where the haulage was located some distance from the power station.

Many of the advantages of electric haulage have been considered incidentally in the foregoing answer. The cost of maintaining

haulways in this system is less, but a better track is required in the beginning than is necessary for rope haulage; it requires more skilled attendance, repairs are more costly, and there are some elements of danger in the presence of the wires in the roadways and travelingways of the mine, even when there is no gas present.

The conditions mentioned above as favorable would rarely all obtain at one time, and in many cases the selection of a proper haulage system is a matter which cannot be satisfactorily worked out on paper, and in such a case, as in all others, the records of experience in similar cases should be diligently examined and applied to the case in hand.

CHAS. E. BOWRON, Birmingham, Ala.

Second Prize.—THEODORE SIMONS, Spokane, Wash.

TRADE NOTICES.

The Ironsides Company, of Columbus, Ohio, has issued an interesting series of catalogues descriptive of its numerous products.

The Sullivan Machinery Co., of Chicago, Ill., has purchased the plant and business of the M. C. Bullock Mfg. Co., of the same city.

The Deep Leeds Transmission Co., of Australia, recently installed a Cross oil filter, made by the Burt Mfg. Co., of Akron, Ohio, in their electrical power station.

Michigan Carbon Works have 28 Austin separators in use in their plant in Detroit, Mich. The Austin Separator Co., of Detroit, Mich., has from time to time furnished 15 separators to the Watkins Salt Co., of Watkins, N. Y.

James McCrea & Co., 11 & 13 S. Canal St., Chicago, manufacturers of the Climax steam joint clamp have recently closed a deal with the Mine & Smelter Supply Co., of Denver, Colo., making them agents for that territory. They carry a complete stock and are in a position to fill all orders promptly.

Recent export shipments of the Ball Engine Co., Erie, Pa., are: 1 40-H. P. simple engine, and 1 75-H. P. compound direct connected engine to Japan. Two 125-H. P. tandem compound engines to Russia. 1 50-H. P. simple engine to Honolulu, H. I. 1 60-H. P. direct connected engine to Vera Cruz, Mexico. 1 150-H. P. cross compound engine to British Columbia. 1 400-H. P. direct connected engine to England.

The Robert Aitchison Perforated Metal Co., 303 Dearborn St., Chicago, are having an excellent run of business. They have recently made shipments to Kentucky, Wisconsin, Utah, Nebraska, and other States. Shipments cover material for railroads, agricultural implements, coal mines, breweries, and other industries. Among recent inquiries are some from Australia, Germany, and the West Indies.

Messrs. Keuffel and Esser, 127 Fulton St., New York, have established a branch house at 303 Montgomery St. (Nevada Block), San Francisco, which will be in charge of Mr. John R. Carr and Mr. W. E. Holcomb, both of whom have been connected with Messrs. Keuffel and Esser for some years past. This branch house is necessitated by the rapid and steady growth of the firm's business on the Pacific coast and it will undoubtedly prove a great convenience and advantage to its many patrons.

The E. Keeler Co., Williamsport, Pa., boilermakers and jobbers of mill and mine supplies, are busy with an order from the Eaglesmere (Pa.) Water Co., for one and one-quarter miles of sheet steel pipe. The pipe is twenty inches diameter, and of No. 10 gauge steel, riveted by hydraulic riveting machines, and each end of sections is fitted with flange connections. The contour of the country is followed, so that a variety of curves has to be made with the different joints and sections of the pipe. The E. Keeler Co. are prepared to make this kind of pipe from ten inches diameter upwards.

Work is now progressing on a new addition to the plant of James Leffel & Co., Springfield, Ohio. This addition is to be 90 x 220 feet, is to be built of brick and steel, and is to be equipped with electrical cranes and a number of new machines, to enable them to supply the increased growing demand for the celebrated Samson wheels. These works will now give work for 300 men. This company has just received an order for a large pair of horizontal wheels from Minneapolis, to develop 3,000 H. P.; and another contract for ten 68-inch Samson wheels from Michigan, for driving electrical machinery.

A unique mechanical draft arrangement consisting of two fans was recently installed at the works of the Diamond Rubber Co., Akron, Ohio, by the B. F. Sturtevant Co., of Boston, Mass. Of its operation the owners write that, "with the forced draft at one end and the induced draft at the other, we are enabled to pro-

duce a terrific draft and can make steam very rapidly indeed. We have been able to produce a pressure of 1.7 oz. by the forced draft fan and maintain a 3-inch water column at the extremity of our underground breeching or at the inlet of the fan. The construction of the fans is neat, strong and workman-like and the engines run cool and practically noiseless. Taking all into consideration we are very well pleased."

The A. Wyckoff & Sons Co., of Elmira, N. Y., manufacturers of wooden water pipe, report the prospects bright for a good year's business. Their works are now running overtime, getting out a number of orders for mine pipe for some of the larger mining operators. The Wyckoff wooden pipe is coming into more general use every year and is a thoroughly satisfactory, durable, and strong pipe, its light weight, easy handling, and durability make it of special value in pipe lines for mine water supply and for the conveyance of mine water it is unexcelled, owing to the fact that it is not injured by the acids usually found in mine water.

The Broderick & Bascom Rope Co., St. Louis, has recently received the following letter from W. S. Lewis, superintendent East Palestine Coal Co., East Palestine, Ohio:

GENTLEMEN:—I send you a sample of a rope that we bought of you four years ago. This rope has been in use ever since in our mine here as a tail rope. This piece of rope was 3,000 feet long. The total length of our tail rope is 13,000 feet long, which was made up with other ropes, but we found this rope to wear twice as long as any other rope in the mine, with the same conditions. This rope was $\frac{3}{4}$ of an inch when new, but now it is less than $\frac{1}{2}$ inch. Too much can't be said of this rope.

The present, and likely to be continued, high price of cotton duck turns the attention of colliery owners to flax brattice cloth now in good quality cheaper per yard than old sails, or duck in the piece. Added to this the advantage that flax presents in its greater durability in damp places, and further the lasting qualities given to the flax brattice by its antiriot dressing, and it would seem to the advantage of all using fabric for air stops, doors, hanging cloths, and similar purposes to employ it. The Mineralized Rubber Co., of New York, has been advertising this brattice in MINES AND MINERALS for a number of years, and is still a leading house in this trade.

The Sprague Electric Company reports an increase of sales over the corresponding month last year. The outlook for this year is exceedingly bright. Among recent orders are one 75 H. P. and four 30 H. P. motors for the Cooke Locomotive and Machine Co., Paterson, N. J.; 35 motors for the Central Lard Co., New York, who placed the order through their electrical engineers, Messrs. Floy and Carpenter; one 400 K. W. generator, one 125 K. W. generator, one 100 H. P. motor and six 80 H. P. motors in addition to a number of small motors for the Wellston Portland Cement Co.; an order placed by Mr. George Hill, 150 5th Ave., New York, for the Dunmore Iron and Steel Company, Dunmore, Pa., consisting of one 62½ K. W. generator, one 100 K. W. generator, and twenty-five motors of assorted sizes; one 75 K. W. generator, one 25 H. P. and one 30 H. P. motor for the National Distilling Company, Milwaukee; one 125 K. W. generator for the Big Muddy Coal and Iron Company, Murphysboro, Ill.; one 100 K. W. generator for the Keystone Leather Company, Camden, N. J.; seventeen motors for the Norfolk Navy Yard; one 50 K. W. and one 75 K. W. engine type generator for the new Windsor Arcade Building, New York; two 75 K. W. engine type generators for the new City Prison, Blackwell's Island; two 100 K. W. engine type generators for the Manhattan State Hospital, Central Islip, and two 300 K. W. 500 volt street railway generators for the Central States Construction Company, Chicago.

The Atlas Pipe Wrench Co., of New York and San Francisco, takes pleasure in informing its patrons that the increasing demand for Atlas pipe wrenches has compelled an increase of facilities and the company is now ready to deliver wrenches in any quantity, and can hereafter promise immediate delivery. This company recently received the following letter from the plumbing department of the Wilmerding School of Industrial Arts, San Francisco, Cal.:

Atlas Pipe Wrench Co.

DEAR SIR:—Thinking it may be of interest to you, I take this opportunity to announce the result of tests given the "Atlas" wrench. I proclaim it superior to all others in many ways, without the disadvantages of many. Points of its superiority are noticed by any one accustomed to the use of such tools, as soon as an "Atlas" is placed in their hands, and with each trial or test other advantages present themselves. The pressure of the jaw being exerted at a tangent to the circumference of the pipe makes it practically impossible to flatten or crush it. To prove this quality by a comparison, an attempt was made with other forms of wrenches, and with extension tongs to remove a brass nipple which was corroded into a fitting. The only effect the wrenches had was to change the form of the round nipple to that of an

ellipse, and the tongs simply caved in one side. With the "Atlas," and after the projecting portion of the metal had been weakened by the previous attempts, the nipple was removed at first trial, without changing the form in which it was when the wrench was applied. The "Atlas" will grasp a pipe at such angle that it is possible to turn it against a plane surface, or even in a niche, in which positions wrenches opening at right angle to the handle are useless. The "Atlas" is better adapted for turning irregular shaped rods, nuts, or fittings, than any such tool I have ever seen, as it adjusts itself to inequalities in size and shape. In handling the large sizes of pipe with the old style of chain tongs one is made to feel that nature has not provided hands and feet enough for the operation in hand. With a pair of "Atlas" wrenches the work is done with such ease that one pair of hands will always suffice. The "Atlas" has not been found wanting in tests of strength, and its parts are so few that there is nothing to get out of repair. The separable jaw makes it possible to obtain practically a new tool by inserting the new teeth when necessary, in an old wrench. Hoping there may be some satisfaction to you in knowing the result of our experiments, and these expressions of my disinterested and unsolicited opinion of a valuable tool, I remain,

Yours sincerely,

G. F. WOOD,

Instructor in Plumbing Department.

Wilmerding School of Industrial Arts,
San Francisco, Cal., Jan. 12, 1901.

The Mineral Exhibits of the Pan-American Exposition.

Written for MINES AND MINERALS, by Dr. David T. Day, Superintendent of Mining, Pan-American Exposition.

The mineral department of an exposition, like the forestry department, is quite widely distinguished in its nature from other branches. It is quite necessary for the mining branch to exhibit the mineral resources of the country where the exposition is held, just as the forestry exhibits must be made to show to the public whatever timber wealth the country has.

In the mining exhibit the first essential is to familiarize the general public with the appearance of valuable minerals as they are found in the ground in order that the visitor may be prepared, after sufficient careful study of the exhibits, to recognize mineral substances in their crude state somewhat more readily than before, and if we may judge from the inability of most persons to distinguish between such widely different minerals as native gold and valueless yellow sulphide of iron, an exposition can teach a great deal in this way in a very short time.

The greatest space in the mining exhibit must therefore be devoted to showing all the varieties of natural mineral substances just as they come from the earth, and then the remainder of the space may well be devoted to showing useful products in more refined stages, which can be obtained from these crude minerals, the methods by which they are taken from the earth, and the processes by which they are made useful. All of these features have been considered in arranging the mining exhibit at the Pan-American Exposition. If one specimen were shown of every kind of useful mineral, with the products which come from it, the greatest need of the visitor would have been supplied, but a second consideration would not have been satisfied. It is interesting to the visitor to know what regions in the country yield each kind of mineral, in other words, the visitor would be greatly benefited if he could take away in his mind a map of America on which every mineral obtained from it was shown, and shown in exactly the way it occurs. Moreover, the visitor is not the only one to be considered. The great rivalry between different sections of the country results in a wish coming from each section to have the minerals of that section brought most prominently before the visitor's eyes, and in most all of the States rich in mineral resources, efforts are made to group under each State impressive collections of its mineral products. How this has been accomplished in the Mines Building is shown below.

Our really most valuable mineral resources are coal and iron. These are, for the average citizen, far more useful than gold or silver. Both coal and iron will be shown by collective exhibits of the coal and iron ores from all parts of the United States, with descriptions and analyses of each specimen so that the visitor may become familiar with the characteristics of every variety. This will be supplemented by special specimens from the other American countries, especially Cuba and Porto Rico.

In order to carry the visitor a step farther, the uses for these substances will be shown in special exhibits where, beginning with the geology of the coal in the most important districts, the adaptability of the material to its several uses will be expanded upon. In the exhibits from Maryland and Pennsylvania enormous blocks will be exhibited showing the conditions in which coal exists underground, the way a mine is opened to extract this coal, the amount of gas and other products which can be obtained

from our best gas coal, the coke which is left behind in this process, etc. Another exhibit will be devoted to showing the different sizes of coal sent out from an anthracite mine, from the largest lumps of steamboat coal to the very smallest sizes extracted from the waste culm banks.

The iron ores of the United States will be shown in equally great detail and also the great industries developed from them, especially the conditions of iron ore mining in the Lake Superior District, the transportation, and the uses of these iron ores.

Although iron and coal are most important, greatest interest to the general public is attached to the conditions of our mineral treasures, gold, silver, and precious stones, and the exhibits of these will be given greatest prominence. Thus, in the center of the building, a large case will be devoted to a collective exhibit of the gems found in America, together with the most unique and interesting specimens of gold and silver. Surrounding this will be other cases containing natural gold and silver and other ores in all the manifold varieties which the visitor must understand if he would become a prospector for the precious metals. For example, a study in the color of native gold will be instructive. The gold will be shown in the first place chemically pure. This is not natural gold but gold made absolutely pure by refining processes. Even here the gold will differ according to the methods used, gold which has been melted being of a much brighter yellow from that shown as obtained by electrolytic processes. The nearest approach to this chemically pure gold will be gold from Grass Valley, Cal., in beautiful yellow crystals almost chemically pure. Other varieties of gold from California shade from this high grade of purity to quite base, almost copper colored, as some of that from Alaska, but if the prospector should familiarize himself with all of these varieties, he would only be acquainted with gold occurring as native metallic gold and he might pass by unnoticed the grayish white telluride gold characteristic of the Cripple Creek districts in Colorado. Passing on to greater complications, the different kinds of rocks containing gold will be exhibited.

This central court will also contain a great variety of the ores of lead, copper, zinc, quicksilver (mercury), and other metallic substances, arranged according to the same method and labeled with the greatest care. The same effort to familiarize the public with the mineral wealth will be extended to the non-metallic treasures of the earth, such as marbles, wonderful petrified wood from Arizona, onyx, our various building stones, and even salt. In connection with this latter subject, the uses for this very common mineral will be particularly interesting. For example, the products obtained from it in converting it into soda, by the Solvay process, will be compared with those obtained at Niagara Falls and some recently at Sault Sainte Marie by the electrolytic process, a little plant for which will be in operation.

In order that the principal mining regions may become familiar to the visitor, maps will be distributed showing all the regions in the United States where valuable minerals have been found. In addition large maps will show all the mineral localities of North and South America. Again, the minerals will be grouped according to the States, thus, New York State will occupy a large space enclosed in a handsome facade; the minerals of Maryland will be grouped. Great care has also been used in exhibiting the peculiar mineral deposits of the State of Georgia. Tennessee's mineral wealth will also be shown collectively, and, going farther west, Michigan, Missouri, Arkansas, and all the great mining States, Colorado, New Mexico, Texas, Arizona, Montana, Washington, Oregon, and California will vie with each other in the beauty and system of their arrangements of their minerals.

Finally, the utmost effort will be made to familiarize the visitor with the machines for extracting minerals from the earth from the more primitive methods of years gone by to the latest up-to-date processes.

At a meeting of the International Geological Congress held in Paris during the summer of 1900, Professor T. C. Chamberlin of the University of Chicago, suggested the formation of an International Geological Institute, the purposes of which may be summarized as follows:

1. The collection, systematic arrangement, and publication of existing and forthcoming data bearing upon the fundamental facts and principles upon which a final classification must be founded.
2. The gathering of literature, especially that now least accessible, and, so far as practicable, of typical collections bearing on the special objects of the organization.
3. The elaboration of data by combination, computation, and correlation, both independently of all hypotheses and in specific application to the various hypotheses that may be propounded.
4. The encouragement, and so far as practicable, the conduct of field investigations in regions not cultivated by existing organizations, nor reached by private enterprise.

IMPROVED HEMINWAY PROCESS

Of Coking Coal in Beehive Coke Ovens as Used at the Plant of the Universal Fuel Company.

Written for MINES AND MINERALS, by Dr. R. S. Moss, General Manager, Universal Fuel Co., Chicago, Ill.

This improvement relates to the method of coking in a beehive oven, and has for its object not only the production of a good sound metallurgical coke from so-called non-coking coals but also the improvement of the practice of coking the well-known grades of coking coal.

It is generally admitted that a good coking coal must contain from 20 to 30 per cent. volatile matter; it must be low in ash and sulphur; and when subjected to a coking heat must fuse or become pasty; and whilst in this pasty condition it must give up its volatile matter in such form that during its evolution from the pasty mass of coal it will push a number of carbon particles together so as to form strong cell walls, separated from one another by pores.

Suppose the volatile matter in a coal is over 40 per cent.; it naturally follows that one must change or modify the ordinary practice followed in beehive ovens because the greater volume of volatile matter would increase the size of the pores and thus weaken the carrying strength of the coke, unless the strength of the cell walls were correspondingly increased; all this providing the rate of evolution of volatile matter was the same in both cases; but suppose the volatile matter in the latter case is evolved at a much greater rate; might not this rapid evolution have a tendency to cause more pressure in the oven and thus close the pores, in fact might it not even change the shape and regularity of the cells as well, thus producing a coke too dense and one that would not absorb the hot gases in the blast furnace under usual conditions.

I consider it possible to obtain good results from coke whose cell structure is not exactly similar to the recognized form; I also consider it possible to alter the cell structure of a coke at will during the time of coking by an intelligent manipulation of the pressure in the oven, which can very easily be accomplished by the use of my improved method of coking.

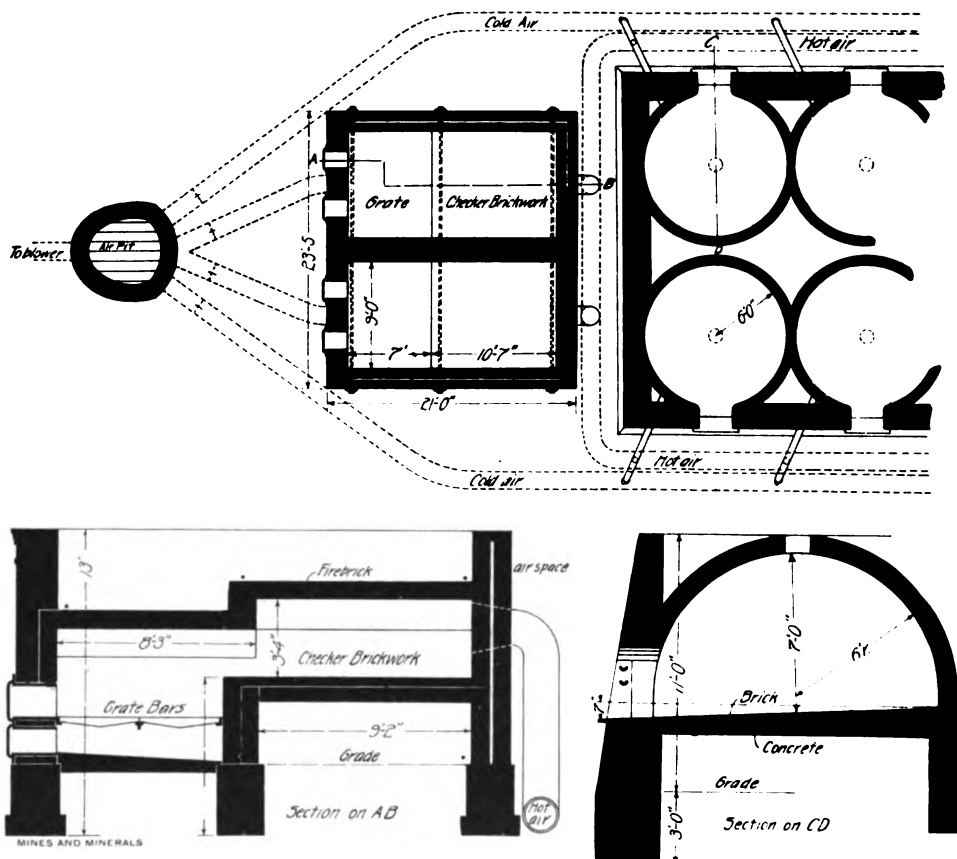
It is well known that the fusibility of a coal does not depend upon the volume of volatile matter present in the coal; however, the greater the fusibility of a coal the greater the range to which it lends itself for easy change of the size, and arrangement of its cells; but what effect does this have upon the carbon regarding its efficiency for blast-furnace work?

Suppose I produce a very porous and a very dense coke from the same coal, does it not follow that although the per cent. of fixed carbon is the same in both cases yet the efficiency under same conditions in a blast furnace will vary between wide limits; but is this the fault of the material or the method of operating the blast furnace? The same heat units are represented in both the porous and the dense coke, they are both strong enough to bear the usual burden of ore, and yet the proportion of coke to ore is very much greater in one case than in the other. This assumes that carbon in all its various forms, as found in coke, will develop the same efficiency. But does it? If oxidized directly to carbonic acid its efficiency must necessarily be the same, but as a matter of fact two cokes of exactly similar analysis give different efficiencies; what is the cause? Clearly this can be very readily ascertained by making a simple analysis of the gases escaping from the blast furnace. It will be found that the ratio of carbonic acid to carbon monoxide is higher in the gases from the coke showing the highest efficiency, and vice versa; but why should one coke give a higher efficiency than another where the fixed carbon in both is equal? Obviously oxidation of the fixed carbon is not equal, and as oxidation depends upon the air supply, all other conditions being the same, the pressure of

air or the volume or both, must be changed; but here again is a limit to which we can either increase or decrease pressure or volume or both, to advantage; but as this limit lies within very wide margins it will be found in practice that equally good results may be obtained with either a dense or porous coke, providing they both hold the burden, by manipulating the air supply either as regards pressure or volume to suit the coke.

Let us return to our coke ovens. When I took charge of the Universal Fuel Co.'s plant I found a battery of four experimental ovens in operation under the Heminway process; to these ovens a by-product plant had been attached; the arrangement was such that the gas was taken off from the trunnel head, thence to a small hydraulic main placed at some considerable distance from the ovens, thence through a Root exhaustor to a Pelouze & Audonin's condenser; from there through a scrubber and thence measured through a proportional meter to a purifier and on to the holder. I found this arrangement both useless and dangerous. Good hard coke was being made from Western coals and everything appeared favorable as regards the matter of coking.

By the Heminway process air, hot or cold, was blown into the oven just above the top of the coal. If the oven was rather



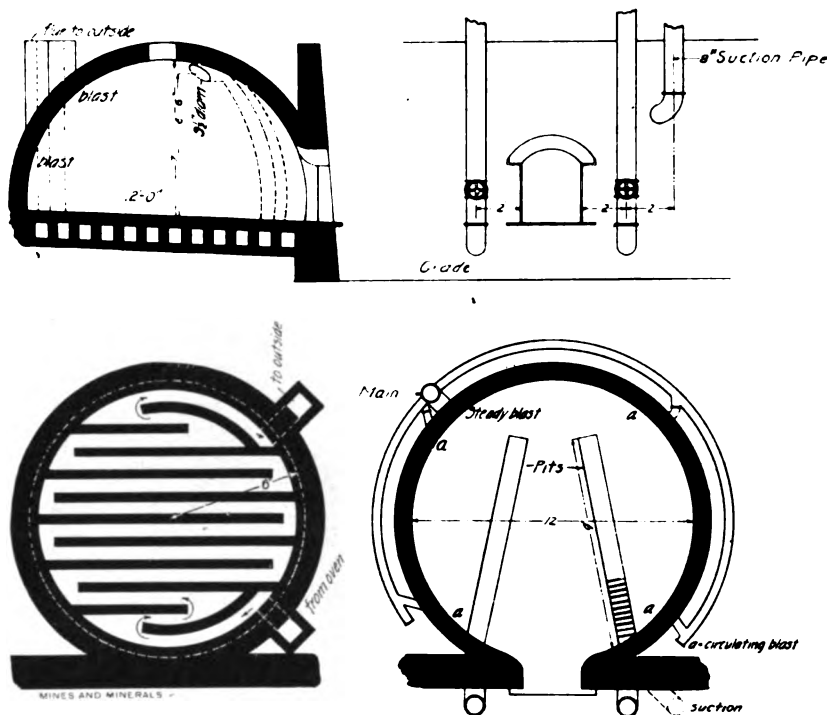
PLAN AND SECTIONS IMPROVED BEEHIVE COKE OVENS.

cold or the charge did not readily ignite hot air was used; the air being heated by first passing it through firebrick checker work in a furnace external to the oven, the air in its passage through the checker work being heated to 800 or 700° F., thus aiding combustion. The amount or volume of air either hot or cold was not regulated in proportion to the amount or volume of the volatile matter which was given off from the coal, hence the object aimed at was not gained at all times. If an oven appeared hot the air was put in and the oven was blown continuously, resulting in nothing more than further heating the air, which, passing off from the trunnel head carried considerable heat from the brick work, hence cooled down the oven, so much so that after the expiration of a few hours the oven was very much cooler than when charged. The coal did not coke and the inevitable result of an oven making breeze and not coke was obtained. This had been the case time and again; the cause assigned by those in charge was deterioration of the coal used due to the weather, or perhaps it might be the effect of a few days longer on the road from the mine to the works; or it might have gotten wet in transit, etc.; be that as it may, whilst we all know that coal does deteriorate if exposed to atmospheric changes yet I have never heard of any coal undergoing such remarkable changes in such a short time.

It has been found that whilst the Heminway method does increase rapidity of combustion yet the rate of coking is seriously disturbed throughout the mass of coal; for instance, the top layer of coal is coked long before the bottom, hence at the high temperature maintained by this method the coke or carbon in the upper part of the oven is burnt whilst waiting for the lower layer to coke. This is as might be expected; coal and coke are bad conductors of heat, hence the rate of heat penetration throughout the mass of coal is disturbed. The upper layers coke rapidly without giving a corresponding increase to the lower layers.

Let us assume the normal conditions found in bee-hive ovens: five to seven tons of coal are charged into the oven, the coal is leveled off and the door walled up, coking takes place in the usual way and the oven is drawn, we will say in forty-eight hours; black ends are noticed on the bottom, therefore the coal has not been thoroughly coked. If we select a sample of this coke taking it from top to bottom we shall find the volatile matter will increase from above downward; now suppose we take this same oven and attach the Heminway process, again charging the same amount of coal as in the first case—in fact with all conditions remaining the same as before; hot or cold air or both are blown into the oven as deemed best under the circumstances, so that complete combustion takes place inside the oven; it naturally follows that the temperature of the oven, at least the space within the area of combustion, will increase at a much quicker rate

Instead of blowing air direct from an opening having the exact diameter of the pipe through which it is conveyed, I enlarge the exit by making it elliptical in shape, raised slightly on the lower side instead of horizontal, thus blowing the air in a slightly upward direction in the oven and at a height sufficient above the mass of coal to protect combustion of the fixed carbon, by a cushion or layer of volatile matter between the coal and the air supply; at a point three feet at least from the center of the air exit I add a second air supply also elliptical in shape and placed almost in a horizontal plane, thus completing combustion of the volatile matter that escaped the lower supply of air. It is obvious at once that the form of my exit will ensure a better and more even mixture of air and combustible gas than when the exit is round. It prevents cutting or channeling of the volatile matter and gives a better diffusion; then again it is well known that to obtain complete combustion a considerable excess of air is required, hence if we depend entirely upon one air supply a considerable volume of inert nitrogen must be thrown into the oven, thus absorbing heat and hence carrying it off at the trunnel head. If complete combustion is not obtained a large amount of combustible volatile matter passes out at the trunnel head and is consumed in the open air without giving any heat to the brick work in the oven. By adding a secondary air supply it does not become necessary to blow as much air into the oven from the lower pipe. Combustion of part of the volatile matter takes place; the heat produced by this combustion is transferred to the whole of the gases, hence the unconsumed volatile matter reaches the secondary air supply at a higher temperature than would otherwise be the case; hence such an excess of air is not required to obtain complete combustion as is the case with only one air supply, and the whole of the combustible matter is consumed inside the oven, thus preventing loss of heat due to combustion on the outside of the oven. This is all very well as far as it goes, yet it alone only increases the disproportion or rate of coking throughout the mass of coal in the oven, and hence aggravates rather than lessens the trouble met with in the Heminway process of coking; for with this increased heat above the coal the top layer of coal is coked much more quickly than in the Heminway process, and even long before the coal on the bottom of the oven has given off its volatile matter; hence we must either draw an oven with coal on the bottom not coked at all, or we must run it until coked, when the fixed carbon on the top, or rather the coke, is being consumed and the top is ashed over, reducing our yield very seriously as well as increasing the percentage of ash; therefore one can see that this improvement in itself is useless. To overcome this difficulty I have built a flue from the inside of the oven just below the trunnel head, carrying it down the outside of the oven and under the bottom, starting near the front of the oven and continuing along the bottom to the back, and again passing outside to a main flue built between the ovens, where the gases may be utilized for raising steam, and thence to a chimney discharging into the outer atmosphere. I have built twelve flues under the oven and thus equalize the heat from front to back; the front being the coolest part of



PLANS AND SECTIONS SHOWING ARRANGEMENT OF FLUES.

than in the first case; hence, all other conditions remaining the same, it follows as a matter of course that the increased disproportion of heat distribution in the latter case must tend to set up an unequal rate of coking throughout the mass. Suppose the oven is drawn just as soon as the top is well coked, the yield of coke will be high, yet it will vary in hardness and amount of volatile matter from above downwards, showing large black ends, practically nothing but fused coal on the bottom; then again if we continue to coke until the whole of this volatile matter has been eliminated and the coal is thoroughly coked to the bottom, we shall find our yield much less than the loss of volatile matter above would indicate, due in this case to the coke having been consumed on top. This teaches that the ideal coke oven must, if possible, be evenly heated; it must evenly maintain that heat so that the whole mass may be completely coked, as nearly as possible, at one and the same time. If our material were a good conductor of heat the problem would be very much easier, but as we must depend upon the heat radiated from the firebrick walls and bottom of our oven, it takes considerable time before that heat and the heat of combustion combined penetrate through the mass of coal; this in a bee-hive oven; in a closed oven the trouble is not exactly the same, as this latter method is one of distillation by means of a furnace external to the oven. To overcome the difficulties met with in the Heminway process I have made a number of improvements which are herein set forth and discussed.

the oven in a battery built back to back decided my taking or rather starting in from the front, because the protection of the other ovens on the sides and back maintains a slightly higher temperature than in front where the oven is not protected, hence the gases at their highest temperature enter the bottom flues at the coolest part of the oven. By carrying the waste gases from the top underneath the floor of the oven I equalize, to a great extent, the difference in temperature between the top and bottom of the oven; not only this, but I also increase the rapidity of evolution of the volatile matter from the bottom and thus in a given time remove a greater volume of combustible matter than is possible in the Heminway or old process. This increased combustible matter requires a larger volume of air for its combustion, hence I open the top and bottom valves connected with the air supply, and thus add the required increase of air. This increased amount of air and gas by their combustion increase the amount of heat produced, hence the waste gases passing under the bottom of the oven, carry a corresponding increase of heat; the greater volume of air and gas gives a greater volume of waste gases, all of which are conveyed under the bottom of the oven, not only equalizing the heat in the mass of coal but also increasing the rapidity of coking the coal, thus materially reducing the time of coking in addition to obtaining a more even coke and one entirely free from black ends, to say nothing of the increased yield which I obtain. I find it an advantage to build

a double floor on the bottom of the oven because of the increased amount of heat retained than when single. One must also build the floor of the flues of sufficient thickness to prevent undue loss of heat below; it must be protected by a sufficient thickness from the effect of atmospheric changes as well as climatic conditions, such as difference in temperature between winter and summer, excessive rains, etc. The place and location of the ovens will readily determine what precautions are necessary to retain the heat on the bottom so as to obtain the most effective work.

To still further obtain a more intimate mixture of air and gas in the oven I have added four openings in the oven on a level with and in favor of the one lower oval-shaped opening. I thus throw air into the oven at four separate points equidistant from each other, thus reducing the danger of unequal and incomplete combustion; the directions of these four openings are such that a line drawn from the lower side of each opening will strike a point just below the trunnel head in the oven. One can easily see that a very complete mixture of air and gas is obtained. If necessary two more openings for the admission of air may be added in favor of the one upper opening, these openings to be directly opposite each other and almost horizontal with the face of the oven; this will insure a secondary air supply which will thoroughly and evenly mix with the gases coming from below and result in complete combustion of all volatile combustible matter escaping from the lower part or strata of combustion.

Whilst this is a great advance over the old method yet the rate of coking through the mass is not as even as might be desired. We have in this case our oven hotter at all times on top than on the bottom and less toward the center than on the bottom; to overcome this I have arranged to pass either air alone, or air and waste gas, or waste gas alone, under the bottom and up through the mass of coal in the oven by means of flues or perforated tile, or any arrangement that will allow the air or gases to pass up through the whole bottom of the oven; for instance, in my first trial of this I used the flues built in the bottom of the oven which I designed for drawing off gas, tar, and liquor; the flues two in number are six inches wide and nine feet from back to front; in a twelve-foot oven they are arranged at equal distances apart and are

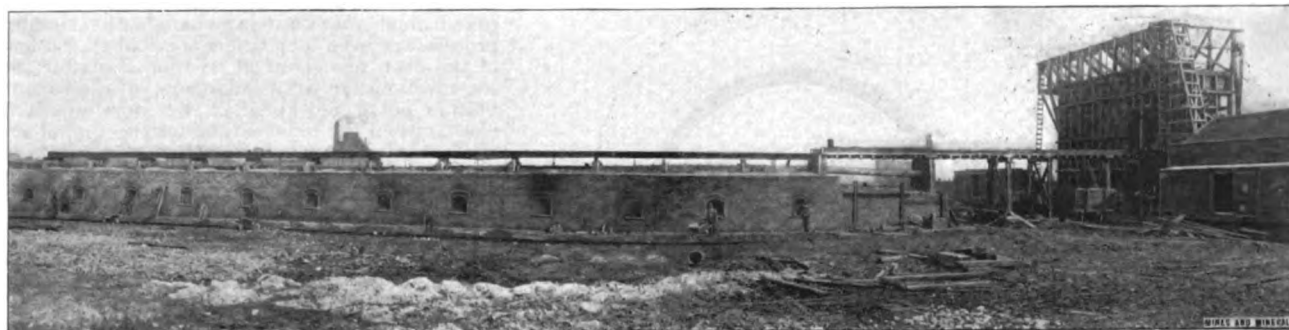
through the air flue on the top, or, if the heat is not fairly even, a part of these or the whole of these gases are carried to the bottom of the oven where they come in contact with air blown into the bottom; hence combustion of the volatile matter takes place, protecting the fixed carbon on the bottom of the oven; and yet by the passage of this hot burnt gas it distills the volatile matter remaining in the mass of coal above the coke on the bottom, and hence the heat passing rapidly and evenly from top to bottom and from bottom to top, produces an even rate of coking throughout the mass of coal. I was led to this improvement through chemical methods which I have devised for the removal of sulphur and which demand a quick temperature throughout the mass of coal to decompose the chemicals used and bring about the necessary chemical reactions, without injury to the fixed carbon. This I will explain more fully in another article.

The battery of 24 ovens shown below are built after the plans of writer as shown herewith. These ovens are now in operation producing results which exceed even my anticipations. I am able to coke a 5-ton charge of so-called non-coking Illinois coal in 24 hours, and the coke is superior in quality. I am able to use duff which costs 25 cents per ton at the mine, but am now using pea coal on account of the moisture in washed duff at this time of the year, about 30% which is frozen and takes too long to draw off in the oven.

The following are analyses of the coal and the coke:

ANALYSIS ILLINOIS COAL.				
Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.
2.80	33.58	56.98	7.19	1.32
5.71	32.61	52.26	9.42	1.98
4.60	31.60	56.90	7.00	1.10
4.35	31.16	56.79	7.70	1.30
4.57	31.53	56.06	8.84	1.18
COKE ANALYSIS.				
0.10	0.80	87.37	11.73	0.90
0.09	0.64	88.89	10.38	0.76
0.08	1.08	88.71	10.18	0.35
0.10	1.64	87.45	10.81	—

The whole of this work, which I have devised and carried into practice at this plant, has been especially arranged to treat



UNIVERSAL FUEL COMPANY'S PLANT BEEHIVE COKE OVENS.

covered with perforated brick one-fourth inch wide on top and one-half inch on the bottom. Air was blown in the bottom through these flues and as might naturally be expected combustion was very intense over the flues, so much so that it channeled and rapidly consumed the volatile matter in the coal directly over the flues. The coal along this line coked very rapidly, leaving a depression the shape and length of the flue on the top of the coke due to the quicker coking over the flues and consequently quicker contraction. Near the front of the oven or at the point of least resistance to the passage of air, large holes appeared, through which the air passed readily to the top of the oven; however, even with this crude arrangement, the coke came out good; black ends in this case appearing on top and not on the bottom of the coke. The time of coking was still further reduced, and I consider, with the perforated bottom and intelligent management of all the improvements herein set forth, we shall still further reduce the number of so-called non-coking coals, besides reducing time of coking of all coals now coked, coking a 7-ton charge in 36 hours equal to 72-hour coke, improving the quality and increasing the yield so that it runs very close to what is found on analysis. The importance of this perforated bottom for the admission of air, or waste gases, or a mixture, can not be overestimated; but like all improvements it can be made worse than useless by ignorant operation. When air is blown into the bottom of the oven the volatile matter in the coal is consumed; at the point of combustion considerable heat is produced which, passing from below upward, distills the volatile matter above and this increased yield of volatile matter increases the volume of combustible gases, hence a greater volume of air is required. This is supplied either

all kinds of coal and is working with the greatest possible success. All my improvements herein described are the sole property of Mr. L. Z. Leiter; my by-product gas plant is working with the greatest success, and will be described in another article, it is the first time coal gas, tar and ammonia in addition to metallurgical coke have been successfully produced in a bee-hive form of oven.

Coal Statistics State of Missouri Year Ending June 30, 1900.

Through the courtesy of Mr. Chas. Evans, Inspector of Coal Mines for Missouri, we are enabled to give the following statistics for the coal mining industry of Missouri:

Number of coal producing counties	36
Number of mines operated the past year including strip-pits	350
Number of mines employing ten or more men	138
Number of fans in use during the year	61
Number of tons of coal mined during the year	2,995,022
Total amount received for the output	\$ 3,643,975
Average price received at the mines per ton	1.21
Number of men employed during the winter season	8,698
Number of men employed during the summer season	6,601
Number of miners employed during the winter season	7,065
Number of miners employed during the summer season	5,300
Number of other employees employed during the winter season	1,643
Number of other employees employed during the summer season	1,298
Number of kegs of powder consumed	69,460
Total cost of powder to the miner	\$ 138,588
Number of men fatally injured	10
Number of men non-fatally injured	23
Number of tons of coal mined for each fatal accident	299,502
Number of tons of coal mined for each non-fatal accident	130,218
Number of new mines opened during the year	12
Number of old mines abandoned during the year	4

MINING IN COLORADO.

Epitome of Report of the State Bureau of Mines, Colorado,
1899-1900—By H. A. Lee, Commissioner of Mines.

The report starts with a review of the progress of mining in Colorado during the past year, which it concludes is very satisfactory for Colorado.

Whilst "booms" on mining should be as a rule discouraged, yet they have expedited development and production, and "excitements" have led to research which has often been rewarded.

Mining began in Colorado with placer mining followed by quartz mining. The precious ores were found associated with other refractory metals not susceptible of treatment in the sluice box or pan. So mills of all sorts and kinds came into being, most of them erected in early days on extravagant ideas. Failures followed naturally, mines were abandoned. Failures were due to men rather than to mines. The advent of railroads into the mining camps gave a great impulse to mining.

In '93 came the depression in silver and with it many a crash in the mining field. To operate at a profit, more conservative methods had to be used or invented and attention was drawn to the treatment of low-grade ores which hitherto had been left untouched for "the future." This resulted in the invention and establishment of new and successful milling plants and processes.

Prior to 1874 the prospector did all his work with a gold pan and claimed to have no use for an assayer. From '74 to '90 the gold pan was almost discarded and he depended on the assayer's returns. So complete however was the change that few asked the assayer to determine more than the silver and lead contents, assuming gold not to be contained in the ore. That was in Leadville's silver days. Cripple Creek however changed and modernized the prospectors' ideas. He now enters the field with the gold pan, but when he fails to get satisfactory returns from it has access to the assay furnace.

The geology of ore occurrence has been much enlarged in its area, gold under certain conditions being found in rocks representing the whole geological series.

Under present conditions old or abandoned properties are being made productive. Old dumps are being worked over at a profit. Miners are obtaining working leases on all sorts of properties. The value of mining property today is based upon a knowledge of what it *will* pay rather than what it *may* pay.

Prospectors are now having a proper respect for the true expert or mining engineer and his opinions. Numerous investigations have satisfied the writer (and we can confirm his statements by our own experience—Editor) that prospectors often actually believe their own misstatements and have no wish to be dishonest.

The mine investor, too, has learned no longer to trust his own eyes or the statements of interested parties, but before investing employs a competent mining engineer to examine and report on the property.

Mining promoters are of two kinds. One who knows practically nothing of mining, who is either an adventurer or an enthusiast. The other a thorough business man with enough mining experience to know that through a competent and reliable mining engineer's report the value of a mine can be fairly estimated as an investment.

The hard-headed business man, whilst cautious at first, is likely in time to be inoculated with the enthusiasm of the first class of optimistic promoters and to himself invest and encourage his business associates to do likewise.

Failure is often the result of an over estimate of dividends and under estimate of expenses for development, etc.; too much cash invested in the purchase of the property, much of which is used to cover commissions; over capitalization; sale of all treasury stock leaving no reserve fund to draw upon; dependence upon property to yield sufficient profit to meet deferred payments of purchase as they become due. Failure, in short caused by a radical departure from business methods.

The true promoter of the second class seeks developed mines with a long record of production, is satisfied with a reasonable commission dependent on the future probabilities of the mine or the so-called "good will" which is always a consideration in the purchase of an established mercantile business.

In mining, the advice of a mining engineer should be sought before investment is made. He may not be able "to see any farther into the ground" than the miner or promoter, but he will see all there is to see and state what he has seen and no more, without prejudice or self-interest, having no interest in the transaction beyond his professional standing and the agreed-upon fee for his services. Good advice may seem expensive but it is far wiser to start right or not start at all.

The purchase of a "mine" and a prospect are different propo-

sitions. A mine is an established business. The engineer determines the amount of stock on hand, its gross and net value and value of plant as a whole. The price asked by the mine owner is for the good will of the business. Developed mines are usually good investments. The successful Colorado mining man is in the field for more "holes in the ground" or prospects having promise. He does not expect all his mining enterprises will prove successful or remunerative, but expects that the balance between producers and non-producers will show a good profit. He does not pay a big price for a prospect however promising. Its value cannot be determined until developed. Development costs money. He refuses to pay out cash for the privilege of expending still more to determine whether or not he has invested wisely. The owner of a prospect must afford the mining man time to develop the same with right to purchase for a stipulated price at the expiration of an agreed time during which the same is to be developed.

Knowledge and experience have given place to ignorance, and given a reliability to mining that it at first did not possess. There is still some luck in mining but in the main success is attained by careful attention to mining business and mining methods.

In early days only rich veins could be drawn upon for profit. With railroads, reduction works, new processes and mills, ores valueless a short time ago are today valuable. All mines were at one time prospects and small investments may change a prospect to a mine. The opportunity for judicious investment is almost unlimited.

Then follows a description of the State Mining Bureau, its purpose and utility, and what it has accomplished by determination of rocks and minerals, by supplying an official source of reliable and unbiased information, by the practical utilities of its excellent local museum, library, and mineral collection.

From answers to certain typical questions asked the Bureau, by visitors and others we select the following as pertinent to mining in general.

"Mills should only be constructed after the most careful investigation. First, be certain of plenty of ore to justify the erection of a mill. Second, secure the best talent possible to determine the character or process for the mill required. Third, find some mill of the character in operation and arrange for a practical test before construction of plant.

"The main cause of mining litigation is slipshod or careless methods in first obtaining title. A title should be examined before purchase.

"In all well-managed properties the ore reserves are kept well ahead of ore extraction. As a mine increases its production the ore reserves are usually increased in same ratio. During the time of ore extraction greater ore reserves are exposed by development than were known to exist originally. A mine, however, is not more valuable after it has produced largely than it was before.

"Experience in Colorado has exploded the theory 'of greater values with greater depth.' It may prove so in some cases but in others the reverse.

"The history of crosscut tunnels for developing ore bodies is not favorable to that method of exploitation. In sections or districts where the persistence of ore bodies has been demonstrated by extensive development it may be advisable.

"In new districts with comparatively little development it is safer first to follow the ore down and develop the strength of the ore shoots. This done, the driving a crosscut tunnel resolves itself into an economic question.

"The custom of sinking a 10-foot hole on an ore body and then starting a crosscut tunnel several hundred feet long is bad policy and should be discouraged. The miners adage 'stay with your ore if it goes up a tree' is founded on experience and good judgment."

Then follows the accidents in the Colorado mining field and their causes. The fundamental causes are summarized as follows: Incompetent management, incompetent miners, lack of rigid discipline, carelessness.

Space will not allow us to go into the details of these, but some remarks scattered here and there are worth quotation. For instance, speaking of incompetent management:

"Owing to the ease with which the mining field is entered by all sorts and classes of men, a number of the metalliferous properties operating in the State are managed by those whose mining experience is extremely limited. In nearly all vocations a little knowledge is considered dangerous. Men are dangerous not so much for what they *do not know* about mining but for that which they *assume* to know. If an unskilled man obtains employment as a miner on a plant managed by one who has no actual knowledge of mining beyond presumption, the result from the standpoint of safety is obvious.

"The mining industry of the State has now advanced to a point where farmers, doctors, lawyers, merchants, clerks, and men of all other professions should be permitted to return to

their own work, and turn the work of mining which they are trying to manage over to mining men and mining engineers." "With men in control of properties compelled by legislative enactment to be competent the death rate from accidents would be greatly reduced."

There has been a considerable reduction in the number of fatal accidents since the mining bureau has been established which is due to its efforts.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

- LIST OF PRODUCTS. American Iron & Steel Co. 28 pages.
 PRICE LIST. Broderick & Bascom Rope Co., St. Louis, Mo. 98 pages.
 THE STURTEVANT EXHAUST HEAD. B. F. Sturtevant Co., Boston, Mass. 4 pages.
 AKRON BELTING. The Akron Belting Co., 206 So. Canal St., Akron, O. 4-page circular.
 PATENT STEEL WIRE ROPE. Broderick & Bascom Rope Co., St. Louis, Mo. 8-page circular.
 THE JACKSON HAND POWER ROCK DRILL. H. D. Crippen, 52 Broadway, New York. 23 pages.
 THE LUNKENHEIMER AUTOMATIC INJECTOR. The Lunkenheimer Co., Cincinnati, O. 8-page circular.
 THE ORIGINAL JENKINS BROTHERS' VALVES. Jenkins Bros., 71 John St., New York. 12-page circular.
 COAL HANDLING MACHINERY. C. W. Hunt Co., W. New Brighton, Staten Island, N. Y. 32 pages.
 THE ERICSSON SERIES, Vol. 1, Part V. Ericsson Telephone Co., 206 Broadway, New York. 8-page circular.
 CATALOGUE A. The Laughlin Smelting Furnaces. Cross, Laughlin & Co., Room 400 Fullerton Bldg., St. Louis, Mo. 32 pages.
 SPRAGUE ELECTRIC CO., 527 W. 34th St., New York. Bulletin No. 205, Lundell Motors, 27 pages. Interior Conduit; Catalogue 404, Illustrated, 114 pages.
 MINING MACHINERY. Section Two, Concentrating Machinery, Mills, and Appliances. The Edward P. Allis Co., Milwaukee, Wis. Illustrated. 71 pages.
 WESTINGHOUSE ELECTRIC & MANUFACTURING CO., Pittsburgh, Pa. Circular No. 1040, Self Cooling Transformers, 12 pages. Circular No. 1041, Ammeters and Voltmeters, 8 pages.
 THE IRONSIDES CO., Columbus, O. Ironsides Boiler Scale Solvent, 8 pages. Ironsides Paints, 4 pages. Ironsides Fiber Rope Filler and Shield, 4 pages. What a Few Street Railways Say of Ironsides Products, 4 pages. Ironsides Gear Shield, 8 pages. Ironsides Belt Shield, 4 pages. Ironsides Elevator Wire Rope Shield, 8-page circular.
 GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4239, 16 pages, illustrated. Marine Supplies, No. 7533, 27 pages, illustrated. Ge Porcelain Knobs and Cleats, 1 page. Errata Sheet, No. 7524. Errata Sheet, No. 7528. Repair Parts of Ge-55-A Railway Motor, No. 7532, 14 pages.
 GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4241, 8 pages. The Inspectors in an Arc Lamp Factory, 13 pages. The Edison Three-Wire System, 60 pages. Single-Pole Primary Switch and Fuse Box, 4 pages. Fuse Plugs for 250 Volts, 2 pages. Ge Porcelain Knobs and Cleats, 2 pages. Core Type Transformers for Three-Wire Secondary Service, 11 pages.

The International Catalogue of Scientific Literature.

An International Conference was held in London, June, 1900, to discuss the advisability of establishing an International Catalogue of Scientific Literature. A committee was appointed at this conference to attend to the preliminary work, and this committee recently reported to the Royal Society, proposing that the annual cost of a set of seventeen volumes shall be £17. It was also announced that sets had been subscribed for as follows: United States of America, 68; Great Britain, 45; Germany, 45; France, 35; Italy, 27; Japan, 15; Switzerland, 7; Sweden, 6½; Denmark, 6; Holland, 6; Norway, 5; Mexico, 5; Cape Colony, 5; Canada, 4½; Hungary, 4; Portugal, 2; South Australia, 2; Western Australia, 1; Victoria, 1.

The Royal Society has offered to advance the capital necessary to start this undertaking, and it has been resolved to include in the catalogue all literature published after January 1, 1901.

Boring Machine Adapted for Boring Against Wastes.

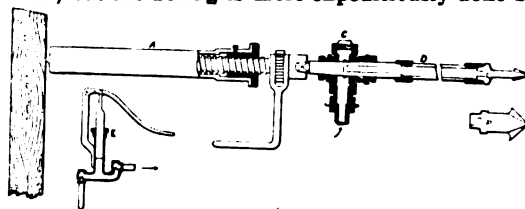
By Robert Martin.

The following device was recently described by Mr. Martin before the Institution of Mining Engineers of England, as follows:

Having occasion recently, in a new colliery, to do a good deal of boring against suspected old wastes in steep ground where pressures were sure to be great, and the quantity of water enclosed unknown, the want of a suitable, easily portable boring tool, that would bore considerable distances ahead was very much felt. None of the ordinary mining textbooks describe such a machine, and those of which the writer heard were thought to be too cumbersome for carrying quickly to and from steep working faces. The difficulty with the ordinary miner's boring machine begins when the bore hole extends beyond the distance required for blasting purposes. The boring tool becomes clogged, unless the borings are cleared away as fast as they are made.

What the writer wanted was a handy tool to bore front holes and flank holes to lengths varying from 50 to 70 feet, and the working face never to be allowed to approach nearer the extremities of these holes than 15 feet. This, it was thought, would always insure an ample barrier of solid coal being left between the new and the old workings. The idea common among some miners that, when straight and flank holes are bored 15 feet ahead, the coal seam to that extent may be worked off, is not a sound one, more particularly if heavy pressures are suspected.

The heaviest part of the machine to be described is the ratchet, which can easily be carried anywhere. It may be worked by one man, but the boring is more expeditiously done by a man



and a boy. Fig. 1 shows an ordinary miner's boring machine, A set against a prop in the usual fashion. The boring rods D are hydraulic tubes (1½ inches in outside diameter and ½ inch in inside diameter) in 6 feet lengths, which are screwed together. The cleaning of the hole is effected by injecting water by means of a small force pump E through the hollow rods to the point of the boring tool, which is 2½ inches in diameter. The water is passed into the tubes at a joint C through a flexible hose on the discharge pipe from the pump. The joint was made from an asbestos-packed gun-metal cock (1 inch), suitable for the purpose. The hollow boring rod, with a hole in it, passes through the cock in the passage made for the plug. One end of the cock is closed and the other is used for injecting the water.

With this machine, a large number of holes were bored up to 70 feet in advance by miners, with no more difficulty than there is in boring short holes. One man and a boy can bore a hole 70 feet long in a shift. No waste workings were discovered.

Adam Cook's Sons, 313 West Street, New York, received the following communication from Y. L. Womble, chief engineer of the Raleigh Electric Co., Raleigh, N. C., under date of January 14, 1901. It will interest all engineers, and especially those who are in search of a thoroughly satisfactory lubricant. "I thought I would write you to express my appreciation of your very excellent Albany grease or compound. I do not believe it has its equal on the market. The results derived from its use are not only remarkable, but startling. I am running three high-speed engines, the cranks of which will not run 30 minutes with anything else. I can now key up rods until they will stand alone on the pin at any angle, and run the engines 24 hours without a stop. I use your No. X Albany grease in an improvised plunger feed cup, viz.: ordinary automatic composition grease cup with piston and spring removed. I cut off the bottom of cup smooth and drilled a hole in the bottom large enough to allow a ½-inch pipe fitting to go through; I then fitted up an iron stud with ½-inch hole through the center. The bottom end of stud I threaded to suit ½-inch pipe tap. The stud has a thin flange or shoulder above the threads and a square filed on it to fit a socket wrench. Each square has a ½-inch hole drilled into center of stud. I hunted around and found a 60-penny wire nail to suit me, and cut it off right length. Screwed the cup on the rod, dropped my nail down in the iron stud. I then tapped out the cup cover with ½-inch standard tap—put in a ½-inch bolt with jam nut on top and gave the nail about ½-inch left by the screw in cover, and put the engine to doing business. It just beats anything you ever saw. Wouldn't exchange that cup full of Albany grease for the finest nickel plated wipe feed on the market today. Come down here and take a look at my rig and find out what your Albany grease can do. I feel you don't know half of its value."

Rock Determination.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it appears like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 516 Boston Building, Denver, Col.

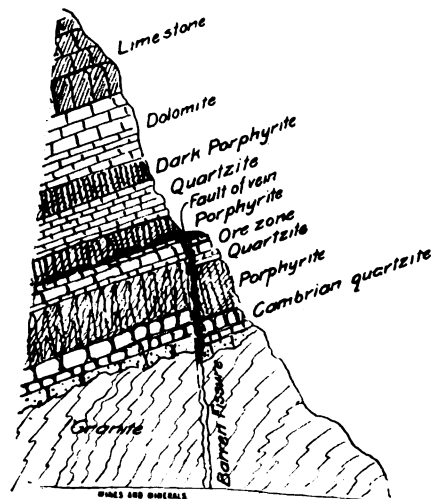
A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Change of Ore Bodies with Change of Country Rock.

Written for MINES AND MINERALS, by Arthur Lakes.

It is well known among mining geologists that a change of country rock may make important changes in the character or continuity of ores and ore developments. This change is partly due to the physical character of the rock through which the vein or vein fissure may pass, and also to other and profounder reasons.



Thus a fault fissure carrying a vein or passing through a bed of limestone may cut a deep fissure in that massive rock, whilst from the solubility of the rock it is likely to enlarge the sides of the fissure and to deposit ore in large cavernous bodies. Should the same fissure enter a compact quartzite, while the fissure may remain clean-cut, it is apt to be narrow and no cavernous widenings to occur, the carbonic-acid of the water having no corroding effect on the quartzite. Should however the waters carrying the ore solutions be heated

and alkaline, they might corrode the quartzite and produce caverns filled with ore as at Redcliff and Ouray in Colorado.

If below the quartzite the fissure enters a bed of schist or slate, the fissure is likely to be pinched or to break up in stringers in the schist. When the fissure reaches the underlying granite or gneiss, it may be that the fissure itself will cease, or that if continued, it may or may not be found productive. These changes should be considered before that often dangerous experiment is tried of running a long cross-cut tunnel into a mountain below the discovered ore deposits with a view of cutting the supposed vein at great depth. These projects are usually made in the massive granite below the overlying sedimentary and porphyry beds in which ore has been found.

In our experience in the South Park and other regions of Colorado, ores and veins found in upper strata, sedimentary or eruptive, do not often continue down profitably into the underlying granite.

In the great San Juan region where great fissure veins appear cutting through an underlying sheet, sometimes 2,000 or 3,000 feet thick of andesite breccia, on reaching the underlying sedimentary red conglomerate rocks the fissures may either cease entirely, or if continued down, may prove unproductive, the same is the case in the telluride bearing veins in the diorite masses overlying sedimentary beds in the La Plata mountains.

In the case of Cripple Creek, we do not know positively yet what will be the result to fissures in the overlying breccia when they reach the granite, as that breccia mantle is so thick that in few cases has the underlying granite been reached. Undoubtedly those Cripple Creek veins which consist of an impregnation by mineral of a volcanic dike, will keep down without limit into the

granite, but simple fissures in the overlying breccia alone may in some cases prove comparatively superficial.

We had a case in point last summer in a mine in South Park. Here large bodies of ore had been found in sedimentary beds intruded into by eruptive porphyrites. These beds were crossed by numerous vertical or nearly vertical faults. The whole series rested on granite. Large bodies of ore had been found at the line of intersection of these faults with the sedimentary beds and their included porphyry sheets. It was proposed to undercut the porphyry by a cross-cut tunnel penetrating the granite and also to shaft down deeply on the granite under that popular supposition that depth must bring greater richness and also that the fault fissure must infallibly keep down into the granite. Fortunately it was not far from the ore bodies in the sedimentaries to go down and reach the granite and when that was found, it was discovered that though indeed the fissure went down into the primitive rock, it was filled only with barren or nearly barren "gouge" matter. This discovery timely put a stop to a projected deep shaft and cross-cut tunnel scheme. It became evident that the ore was confined to the overlying zone of sedimentary and intrusive porphyrites and to the line of faults, so long as that was kept within those upper boundaries.

Fault lines in this South Park region, as has been observed by S. F. Emmons are not generally prolific of ore unless the ore has been leached or dragged down into them from the adjacent or overlying sedimentary and porphyry beds. It would appear in this region that the faulting movements, such as so generally intersect by fissures the South Park and Leadville section of the Mosquito Range, occurred long after the ore deposits were formed at contact between sedimentary rocks and porphyries and by the comparatively recent movement it may be that these fissures are not yet fully filled by ore solutions. In Aspen on the other hand many of the large ore deposits appear to be found at the intersection of faults and shearage planes. In more than one instance in the South Park region, companies have been prevented from the great expense or error of making these long cross-cut tunnels by being shown that there was little chance of encountering any ore deposit of value in the underlying granite, or of the ore deposits found above continuing down into it.

CURRENT MINING DECISIONS.

Prepared for MINES AND MINERALS.

Extent of Rights Conveyed by Deed.—A deed of the surface of a lot of land, excepting and reserving the coal, minerals, and metals in, under and upon it, with right to mine and take out the whole of them without opening for or transporting them over the surface, conveys an open superficial stone quarry, access to which cannot be had profitably except over the surface. Where the reservation of a contract to convey real estate did not contain the word metals, but metals were reserved in the deed subsequently given in the absence of a showing of fraud, accident or mistake, a deed will be presumed to be the final agreement of the parties.—*Snowden v. Cavanaugh* (10 Kulp's Reports, 1) Court of Common Pleas of Pennsylvania.

When Lessor is Not Entitled to Royalty on Screenings.—A mining lease stipulating for the payment to the lessor of a royalty of five cents per ton of 2,200 pounds of all lump coal mined, and five cents per ton on all "mine run" coal of 3,600 pounds mined, does not entitle the lessor to a royalty on screenings, consisting of nut and slack coal left after the lump coal is separated from same, as the words "mine run" coal mean the coal as it comes from the mines.—*Hardin v. Thompson* (57 Southwestern Reporter, 12) Supreme Court of Kentucky.

Evidence of Competency of Miner to Inspect Roofs.—Where a miner whose duty it is to inspect the roof of a mine to determine its safety, and to remove loose earth or rock from same, testified that he had worked in other mines, and in one other nineteen years, and another miner, charged with the same duties, testifies that he had been in the defendant company's employ fourteen months before the killing of the miner for whose death damages were sought, such evidence is sufficient to establish the competency of the miners to make such inspections, there being no substantial evidence of incompetency.—*Fisher v. Central Lead Co.* (56 Southwestern Reporter, 1107) Supreme Court of Missouri.

When One Assents to Sale of Interest He Cannot Allege Private Arrangement.—A part owner of mining claims, whose interest was not of record, but who assented to the bonding of the same by the record owner, has no standing in equity to repudiate a conveyance of his interest by his co-owner in accordance with the terms of the bond, on the ground of a private agreement between them that such conveyance would not be made unless the purchaser took certain other claims bonded separately; nor is it material that the purchaser had knowledge of such interest, the latter being bound by the terms of the bond to which he consented.—*Cline v. James* (101 Federal Reporter, 757) United States Circuit Court of Appeals (Oregon).

GOLD DREDGING.

Things Which Should be Considered in Installing a Plant—Some of the Difficulties and How They May be Met.

Written for MINES AND MINERALS, by F. C. Nettleton.

This article is not intended to be more than a suggestion to those contemplating embarking in the business of gold dredging, with the hope that some of the hints thrown out may be of service in preventing costly errors by those having no experience in the work.

Before going to large expense there are several preliminary questions to be solved. These may be named in the following order: The quantity and physical characteristics of the gold in the ground proposed to be worked; the disposal of tailings; large stones and boulders; depth to bed rock; sedimentary deposit of the stream; fuel supply, and many minor problems which contribute to success or failure. Fortunately, the water supply for sluicing purposes does not enter into gold dredging. Taking these problems in the order named, some detail suggestions are offered.

First, and all important, is the gold values. Many have been the failures from not thoroughly prospecting the ground. Gold dredging implies that nearly all the work to be done is below water line. To prospect this, two means are suggested. The cheapest would be to sink a crib, providing the inflow of water would not exceed the capacity of available pumps. Should doubt exist as to this, a sure way will be to employ the air caisson. Before proceeding with either, the depth to bed rock must be ascertained and a steel box, measuring 1 cubic foot, should be provided as a measure for the samples.

As the deposit is penetrated, samples should be taken at every foot, numbered and panned, at the same time retaining four or five pounds from each sample for assay. Other material from the excavation should be placed on a dump to be sluiced. The use of borings and sand pumps does not appear to give satisfactory data.

If it be necessary to use the air caisson, it should be made of boiler iron and with straight sides, so that it may be pulled out and used again.

The cube foot samples should be carefully panned and the values collected with mercury, observing closely the physical structure of the gold, whether shotty or flake, and noting if the gold is readily taken by the "quick," as coated or light flake gold will require treatment other than the ordinary sluice. A record should also be taken of the nature of the material penetrated.

The following is taken from a report and is given as an illustration:

Pan Tests.	Assays From Samples. Per Cubic Yard.
0 to 1 foot, coarse drift sand	\$.20
1 to 2 feet, coarse drift sand	.20
2 to 3 feet, coarse drift sand	.10
3 to 4 feet, sand and pieces adobe, free washing	.14
4 to 5 feet, sand and pieces adobe, free washing	.27
5 to 6 feet, sand and pieces adobe, free washing, (est)	.07
6 to 7 feet, coarse gravel	.10
7 to 8 feet, adobe	.07
8 to 9 feet, sand and gravel, coarse	.54
9 to 10 feet, sand and gravel, coarse	.10
10 to 11 feet, sand and gravel, coarse	.54
11 to 12 feet, sand and gravel, coarse	.81
12 to 13 feet, sand and gravel, coarse	.14
13 to 14 feet, stones and gravel	.14
14 to 15 feet, stones and gravel, (est)	.07
15 to 16 feet, fine sand	.54
16 to 17 feet, fine sand	.14
17 to 18 feet, large gravel, loose stones and pieces of bed rock	.14
18 to 19 feet, large gravel, loose stones and pieces of bed rock	.20
19 to 20 feet, large gravel, loose stones and pieces of bed rock	.40
20 to 21 feet, large gravel, loose stones and pieces of bed rock	.27
21 to 22 feet, coarse sand, gravel and stones	.27
22 to 23 feet, coarse sand, gravel and stones	1.08
23 to 24 feet, coarse sand, gravel and stones	2.43
Bed rock, gray sandstone.	

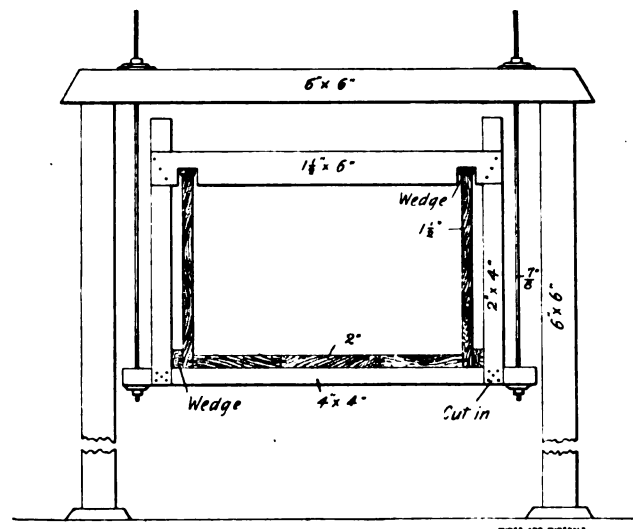
NOTE.—The general average of the first 17 feet is 25½ cents; last 7 feet, 68½ cents; general average, 37½ cents per cubic yard. General average assays \$4.09½. Sluice test average 86½ cents per cubic yard.

It will be observed that there is a wide difference in the result obtained by the pan from that of the one above or below it, while the assays show more uniformity of values. This is the result of indifferent panning. Panning is a slow, tedious process, and at best, there will be instances where the values are thrown out.

After the work of sinking has been completed, the dump should be run through a temporary line of sluice, which may be built as shown in the figure—a mill run as it were. All test results should be calculated to the cubic yard. It would be advisable to sample the pan tailings, and assay, as a check on the other work.

Should the pan and sluice tests show an average value of twenty-five or more cents per cubic yard and with other things favorable, the proposition may be considered a good one.

The second problem is the one of tailings, a troublesome question. It will be found that in the average placer deposit, the stones over 1 inch in size will occupy a space equal to from 40 to 60 per cent. of the excavation from which they came, and will pile up to a height equal to the depth of the excavation, laying at about an angle of 40 degrees. It is therefore necessary to dispose of these coarse tailings at as great a distance from the dredge as possible—not less than 75 feet. The fine tailings should be carried to a



CONSTRUCTION OF SLUICE.

greater distance and beyond the stone pile, to preclude their return to the pit. The reason for this will be explained when in this ideal proposition suggestions are made for cleaning the bed rock.

The third question is the one of large stones and boulders in the deposit to be dredged. Should they appear numerous and of considerable size, the project had better be abandoned. The modern dredge will safely handle stones weighing 500 pounds, but large stones should not be allowed to enter the screens. The surroundings should be carefully studied for this information.

The fourth item is the depth of the deposit. This information should be the first one ascertained. Heavy drills are better than sounding rods for this purpose, as the light rods when striking a good sized stone may deceive. Should the bed rock be found to be below 30 feet, the question of practicability of dredging should be carefully considered.

The fifth item is the one of sedimentary deposits of the stream, if it be proposed to work in the channel. There has been an instance where the silt was so heavy that the dredge was aground practically six months in the year, and the efforts to keep afloat, bankrupted the company. Attention is called to this danger for the reason that those who have not encountered the trouble are very likely to overlook it, especially if the inspection is made at low water stage and the stream is running clear. Inquiry should be made of those familiar with the stream and the channel and bars inspected.

The matter of fuel is all important. The supply, quality and cost should be ascertained.

In discussing the dredge, it may be well to review some of the different devices which have been employed in placer mining. The centrifugal pump as an excavator has been tried and found wanting, to the financial sorrow of investors. Further comment is unnecessary.

The clam shell is not a favorite device for gold mining for reason of its slow action and not being water-tight, permitting the fine values to be washed through its unclosed jaws. The dipper dredge is being used in some instances in this class of work, but it also has the objection of not being water-tight and delivering its load *en masse*, besides which the swing of the crane from side to side would tend to throw the sluices out of level no matter how carefully the spuds may be down. The ideal dredge is one of the endless chain and bucket type. In the following brief outline, it should be remembered that the different makers and operators have each their own ideas of detail arrangement and construction, but the principle remains the same.

The ideal dredge should be as strong as steel and good workmanship can make it in all its parts. Such a dredge cannot be constructed for much less than \$25,000 at the present price of

material and wages, these figures do not include the cost of the barge—from two to three thousand dollars—nor the gold-saving appliance, freights, erections, etc.

This dredge will have water-tight buckets of say four cubic feet capacity each, and when at work should come up with an average load of three cubic feet, and when run at a speed of 15 buckets per minute, will give a delivery of 100 cubic yards per hour. Such machinery would be rated by the builders at from 2,500 to 3,000 yards capacity—meaning 24 hours continuous operation with buckets filled to full capacity. The actual performance of this ideal dredge on an ideal proposition would probably not exceed 1,800 to 2,000 yards per 24 hours on a week's, month's or season's run. Time will be lost in swinging for position, "clean-ups" and repairs.

The revolving screen should be of heavy boiler steel about four feet in diameter and fifteen feet long, with perforated round holes of not less than one inch. Besides the water used for carrying the material from the hopper into the screen, there should be inserted into the screen a spray pipe to assist in disintegrating the material and washing the stones.

The devices for catching gold are numerous, each proposition requiring different treatment, some managers adopting one means and others another. The ideal proposition will have its gold readily taken by mercury and of a shotty nature, both coarse and fine. This being the case consideration will be given to the sluices. The following plan has been found to be very satisfactory, for the reason that the grade can be quickly adjusted without stopping the plant.

In the first box might be placed block riffles of $2 \times 4 \times 6$ inches, set in alternately, on the plan of the checker board, held in place by 1-inch strips running across the box to which the blocks will be fastened in 2-foot sections.

For the second box, Hungarian riffles of $1\frac{1}{2}$ -inch angle iron could be used. The third box could be fan-shaped being the same width as the sluice above and widen to double the size at the lower end. In this box might be placed cocoa matting, covered with expanded metal. This third box should be given a heavy grade.

The three boxes with their different riffles should catch all but the flour gold, and that which is in combination with the silica and magnetic iron. Use quicksilver in the first two boxes.

Naturally, the abrasion of the particles of gold coming in contact with harder material has been very great during the erosion process, therefore, the greater part of the values are in a finely divided state, some of it free and some still attached to or in the quartz, black sand, etc. It may be safely assumed that fully 75 to 90 per cent. of the values in a placer deposit are in this condition and that ordinary sluicing will save but 10 to 25 per cent. Placer men are now devoting much attention to the saving of these fine values. This will have to be accomplished by some system of concentration that will handle the material very rapidly. A concentrator designed for this work has recently been given a trial, concentrates from it assaying \$266 per ton; and it is claimed to handle the material as rapidly as the dredge and screens will deliver. Further operations will be watched with interest, for should it prove thoroughly practical in further trials, it will serve to more than double the output of dredges and similar propositions. Fine concentrates of the kind mentioned would be about one to one hundred of the material in place.

The question of the amount of water necessary for sluicing purposes depends upon the material, nature of the gold and upon the methods employed. For the ideal plant handling 100 cubic yards per hour, the water supply should be not less than 1,000 gallons per minute, but double that capacity should be provided. The pumps supplying the sluices should be run by a separate engine and be under full control of the sluice man, as the buckets do not at all times deliver the material regularly.

The ideal dredge must have a barge built of first class material, thoroughly braced, trussed and calked. Do not attempt to economize in this direction as a bad knot or faulty calking below water line will cause no end of trouble and expense.

Experience has demonstrated that in river placer deposits, the greater values are near to or on bed rock. It is impossible for a dredge to thoroughly clean the bed rock, and it probably leaves more values in the crevices, irregularities and material escaping the buckets, than it brings up.

In this outline, it will be remembered that provision is made that none of the tailings are permitted to return to the pit. To clean this bed rock the following, as yet untried, plan suggests itself. Place in the excavation alongside or behind the dredge, an air caisson, sustained by two floats. Lower the caisson to the bottom, turn on the air and go down and clean the bed rock by hand and dry-shod. After cleaning the area covered by the

caisson, say 100 square feet, raise the appliance off the bottom and float it to new position, and in this manner clean the excavation as it is made. Outside of the first cost, the expense of operation would be trifling in comparison with the probable results. As there would probably be a foot or more of material left by the dredge, it could be blown, by the air pressure (12 to 15 pounds per square inch) directly into the sluices on board the dredge.

Electric Shaft Signal Used at Parker Shaft.

The accompanying illustration shows the Winckler's patented electric shaft-signal-apparatus, in about $\frac{1}{4}$ of its natural size. The apparatus is placed above ground at the top of the shaft and by means of four screws is perpendicularly secured to a wooden-block which is arranged at a suitable place. The single parts of the apparatus are placed in a stable case, *a*, made of cast-iron, which is closed in order to protect it against dust, dampness and similar exterior influences. This case serves at the same time as a guide to the sweep made of best cast-steel, which can be easily moved up and down.

Upon this sweep is put a spiral spring of hardened cast-steel, which is retained by the adjusting collar *c*. This spiral spring is partially compressed by the weight attached to the end of the steel-wire, which forms a prolongation of the sweep down to the pump-cistern, and by regulating the compensating weight the spiral spring can be so adjusted, that it will vibrate by the slightest downward or upward pull.

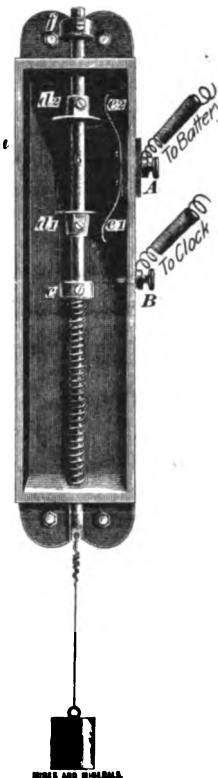
The whole iron body is, as shown in the illustration, through the binding-clamp *B* connected with the conducting wire to an electric-bell, arranged in proximity to the engineer. The closing of the circuit is established by means of the connecting-spring *e*¹ (descent) and *e*² (ascent) and of the two contacts *d*¹ and *d*², which for the purpose of exact adjusting are movable on the sweep. This connecting-spring is connected at *A* with the current battery, and completely insulated from all other parts of the apparatus by means of hard rubber. The battery is therefore only in action if a signal is to be given and as further the two currents (leading to the engine room) are only above ground, the battery remains constant for a long time (about 2 years.)

The arrangement is managed as follows: The sweep consisting of galvanized cast steel wire is sent down the shaft at a suitable place (similar to the old shaft-bell-wire). By means of the compensating weight hanging at the bottom of the shaft, the sweep hangs always perpendicularly and tense. If the sweep is only lightly touched with the hand when descending, a downward movement of the wire will be effected in consequence of the rapid movement of the body of the descending man, the spiral spring will hence be actuated and the contact at *e*¹ will be closed. When ascending, however, the lightest touching of the wire will be sufficient to discharge the spiral spring because a pulling upward will take place and the contact at *e*² will be closed. As soon as the hand leaves the sweep the spiral spring returns to its original position and the contact is interrupted. The sweep may as well run through a simple clamp arranged at the hoisting cage and the signal can be caused by a slight pressure upon this clamp. After the hoisting-cage has been stopped at once in consequence of the signal, one may easily give the bell signal prescribed for every work by a slight pull at the wire and one can easily regulate the movement of the cage.

It is evident that the giving of the stopping-signal is quite independent of the more or less quick movement of the hoisting cage. The spiral spring will be even more easily actuated if the trip is quicker because the pull is thereby only increased.

The arrangement has been closely examined and highly recommended by the royal mining-academy of Freiberg and the mining-engineers have been instructed to employ Winckler's apparatus.

As a particular advantage may be mentioned, that the arrangement will work equally well in shafts which are not perpendicular and further that it will not in the least be influenced by dampness.



AMERICAN INSTITUTE OF MINING ENGINEERS.

The Proceedings and the Papers Read at the Meeting at Richmond, Virginia, February, 1901.

Written for MINES AND MINERALS, by E. W. Parker.

The eightieth regular (being the 31st annual) meeting of the American Institute of Mining Engineers was held in Richmond, Va., February 19 to 22, inclusive. Headquarters were opened at 10 o'clock Tuesday morning at the Jefferson Hotel, where most of the members were stopping, and upon the roof of which was a commodious concert hall in which the sessions were held.

The opening session was called to order at 8 o'clock Tuesday evening, with Prof. Robert H. Richards, of the Massachusetts Institute of Technology, in the chair, Dr. Douglas, the President, having been delayed and not arriving until later in the evening. A brief address of welcome was delivered by Mr. Wyndham R. Meredith, Mayor of Richmond, after which the Institute proceeded immediately to transact some business.

The first paper on the program was a description of the great oil well recently sunk by Mr. A. F. Lucas, near Beaumont, Texas. Mr. Lucas was not able to be present and the duty devolved upon Dr. Raymond, who presented a practically impromptu paper based upon letters received by him from Mr. Lucas. Following this was a talk by Dr. Douglas (who had arrived in the meantime) on the Paris Exhibition. This was illustrated by lantern slide views. The session adjourned early in order that the members might attend a reception tendered by the citizens of Richmond in the parlors of the hotel. During this session the scrutineers of the ballots for officers for the ensuing year were nominated, the scrutineers being B. F. Fackenthal, Jr., Thos. M. Eynon, and Arthur W. Scheafer. The reception was a brilliant social entertainment and gave the members an opportunity to meet the hosts of the meeting and the ladies of Richmond.

Wednesday, February 20.—A session of the Institute was held in the concert hall on the roof at 10 o'clock, the first paper on the program being a description of a new type of air compressor, by Mr. Henry G. Morris, of Philadelphia. Two other papers at this session were one by Dr. C. W. Hayes, of the U. S. Geological Survey, on the Mineral Resources of Virginia, and one by Prof. J. B. Woodworth, of Harvard University, on the history and present condition of coal mining in the Richmond Coal Basin. The scrutineers reported the results of the ballots, showing the election of Mr. E. E. Olcott, of New York, for President, Rossiter W. Raymond, for Secretary, and Theo. D. Rand, Treasurer. Vice-Presidents, to serve two years, C. F. de Landero, Pachuco, Mexico; J. E. Hardiman, Montreal, Canada; John Hays Hammond, Denver, Col. Managers, to serve three years, G. A. Crocker, New York, N. Y.; H. V. Winchell, Butte, Mont.; Clemens C. Jones, Richmond, Va.

The greater part of the morning and part of the evening session were devoted to the discussion of specifications and finishing temperatures of steel rails, papers on this subject being read by Mr. Wm. R. Webster, of Philadelphia, and Robert W. Hunt, of Chicago. The afternoon was occupied in visits to the power plant of the Virginia Chemical Railway and Development Co., and to the tobacco factories of the T. C. Williams Co. The third session of the meeting was held in the concert hall at 8 o'clock in the evening, at which time the papers were presented by Prof. J. F. Kemp, of the Columbia College School of Mines, on the copper deposits of Ducktown, Tennessee; by Mr. E. T. D. Meyers, describing the ship yard of the William R. Trigg Co., of Richmond, and which was visited by the Institute the following afternoon. This ship yard is unique in history from the fact that the contracts were given to Mr. Trigg for the building of five U. S. Navy boats, of the torpedo boat and torpedo boat destroyer class, before he had any yard in which to build them. Four vessels have already been launched, one has been accepted by the Government, one is ready for acceptance, and other contracts have been awarded and the ship yard is not yet complete. The final paper of the evening was one by Mr. Alfred H. Brooks, of the U. S. Geological Survey, on gold mining in the Cape Nome region of Alaska.

Thursday, February 21.—The final business session of the meeting was held at 10 o'clock in the morning. This session was practically devoted to the discussion of papers on the genesis of ore deposits, which were presented at the Washington meeting in February, 1900. The discussions were unusually interesting and in addition to oral contributions at the session, papers were presented in print by Prof. J. H. L. Vogt, of the University of Kristiania, Norway, Prof. L. De Launay, of Paris, France, and by Prof. Richard Beck, of Freiberg, Saxony.

The afternoon was spent in visiting one of the plants of the Virginia-Carolina Chemical Co., the Trigg Ship Yard, and the Richmond Locomotive Works. The annual banquet was served in the dining room of the hotel at 9 o'clock in the evening.

Friday, February 22.—A train was tendered by the Chesapeake and Ohio Railroad to convey the Institute and its guests on the choice of two excursions, one to the pyrites mines of the Sulphur Mines Company of Virginia, at Mineral City, and the other to Charlottesville, for visiting the University of Virginia and Monticello, the home of Thomas Jefferson. Both of these excursions were thoroughly enjoyed by those who took part in them.

The following papers in addition to those read by the authors, were presented either in print or by title during the meeting:

Virginia Mining and Miners, by S. Dabney Crenshaw, Richmond, Va.

Biographical Notice of James W. Tyson, by William Glenn, Baltimore, Md.

Specifications for Steel Rails, by Albert Ladd Colby, Bethlehem, Pa.

Character and Genesis of Certain Contact Deposits, by Waldemar Lindgren, Washington, D. C.

Problems in the Geology of Ore Deposits, by J. H. L. Vogt, Kristiania, Norway.

The Origin of Ore Deposits, by Richard Beck, Freiberg, Saxony.

Discussion of Papers of Messrs. Emmons and Weed, by L. DeLaunay, Paris, France.

The Origin of Ore Deposits (Discussion of Van Hise), by H. Foster Bain, Washington, D. C., and C. R. Keyes, Des Moines, Iowa.

Specifications for Steel Rails, by William R. Webster, Philadelphia, Pa.

Concentrating Tests and Calculations, by Otto F. Pfordte, Rutherford, N. J.

The Forecast of Chemical Reactions from the Algebraic Signs of the Quantities of Heat Liberated, by H. Le Chatelier, Paris, France.

Note on Cheap Gold Milling in Mexico, by Henry F. Collins, Mina de Santa Fe, Mexico.

The Genesis of Ore Deposits (Discussion of Messrs. Emmons and Weed), by Arthur L. Collins, Telluride, Colo.

Mining in the Transvaal, South Africa, by John Hays Hammond, Denver, Colo.

The Coal Fields West of Pekin, by N. F. Drake, Tien-Tsin, China.

Investigations on Magnetic Fields With Reference to Magnetic Ore Concentration, by Walter R. Crane, Lawrence, Kansas.

Survey of the System of Management at the Neudorf Mines, Anhalt, Germany, by Frank H. Probert, London, England.

Notes Upon the Report of the U. S. Geological Survey on the Telluride Quadrangle, by H. C. Lay, Telluride, Colorado.

The Granby Consolidated Smelting Works, Grand Forks, B. C. Canada, by A. B. W. Hodges, Grand Forks, B. C., Canada.

The Missouri and Arkansas Zinc Mines at the Close of 1899, by Eric Hedburg, Joplin, Mo.

Problems of Haulage and Hoisting, by Alexander Bowie, Gallup, New Mexico.

A Study of the Effect of Heat Treatment on One Per Cent. Carbon Crucible Steel, by George William Sargent, Reading, Pa.

Note on the Geology of Southeastern Arizona, by E. T. Dumble, Guaymas, Sonora, Mexico.

The Use of the Triaxial Diagram in the Calculations of Slags, by Ernest A. Hersam, Berkeley, Cal.

Some Recently Exploited Wolframite Deposits in the Black Hills of South Dakota, by John D. Irving, Washington, D. C.

Notes on a Bottom for Copper Furnaces, by William Glenn, Baltimore, Md.

The Caliche of Southern Arizona; An Example of Vadose Circulation, by W. P. Blake, Tucson, Ariz.

Notes on Two Desert Mines, by S. F. Emmons, Washington, D. C.

One hundred and twenty-four members and guests registered at the headquarters during the meeting.

Consul Monaghan, of Chemnitz, under date of October 13, 1900, informed the Department that a Parisian engineer has recently finished a plan according to which the Spanish railroads terminating in Gibraltar will be connected, by means of a tunnel crossing under the Strait of Gibraltar, with the railroad lines of Morocco. Several of the men interested in the scheme are now in Morocco trying to obtain permission to build a railroad in that place. Technically, the plan is not impossible, as it is merely a question of boring through rock. Several plans of this nature—for instance, the tunnel from Calais to Dover, which fell through owing to some opposition, the plan to bridge the Bosphorus, etc.—have recently gone to pieces, and it now remains to be seen, says Mr. Monaghan, how far this scheme will be carried out and to what extent it will receive the support of capitalists.

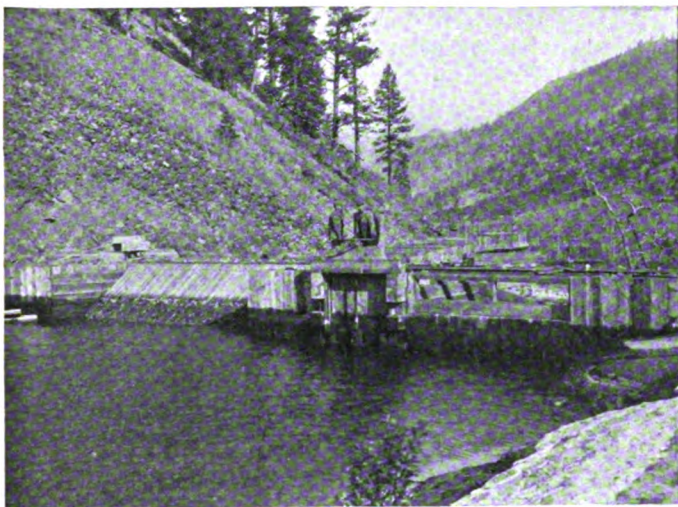
ELECTRIC POWER

On the Comstock Lode—A Description of the Large Electric Generating and Transmission Plant Recently Installed.

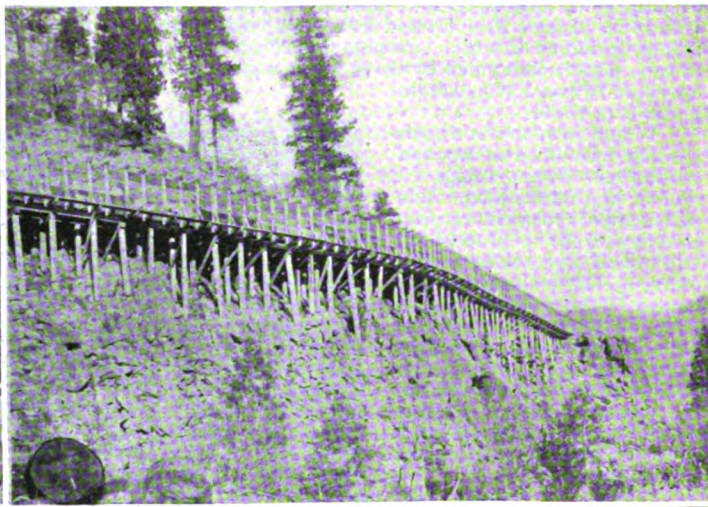
By Wynn Meredith and Wyatt H. Allen.*

The history of the early discovery and subsequent working of the famous Comstock Lode, "the great silver vein of the world," is so well known as to need no repetition. It is situated on the east flank of the Sierras at Virginia City, Nev., and is tapped by several shafts and the famous Sutro tunnel from which hundreds of millions of dollars in gold and silver have been extracted. Up to the present time, mining, milling and pumping operations have been carried on by steam power, using pine wood for fuel, costing from \$8.50 to \$15 per cord. Most of the milling was done on the Carson River, some 15 miles from the mines,

the electric company, the amount to be rebated for power delivered after the completion of the work. The contract is unique and interesting in many respects, but the chief point of technical interest is contained in the clause providing for the measurement of power delivered. This clause asserts that current and power shall be measured by recording instruments at the sub-station, and that the number of horse-power furnished to the mining companies shall be determined by the maximum demand reading of such recording instruments; and in determining what is the maximum demand during any month, the highest reading of the instruments for any period of time exceeding five minutes shall be taken, except where any motor directly connected to a hoist be used, in which case the maximum demand shall be determined by the highest reading of the meters for any time exceeding two minutes. The Truckee River heads in Lake Tahoe and flows northeast through California and Nevada. It is fed by the snows of the Sierras, its rise and fall being approximately 8 ft.



HEAD WORKS AT FLUME ENTRANCE.
POWER HOUSE.



SIDE-HILL CONSTRUCTION OF FLUME.
SUB STATION AT VIRGINIA CITY.

where water could be obtained at a small cost, the ore being hauled at first by wagon and later by railroad. A small quantity of water is brought to Virginia City through 40 miles of flume, and sells for \$20 per miner's inch per month. Mine pumping is now done with this water in a jet pump under a head of 2,400 ft.

During the summer months of 1899, the Truckee River General Electric Company was incorporated for the purpose of erecting a power plant on the Truckee River, in California, to furnish electric power to the Comstock mines, and in August of the same year an agreement was entered into by the electric company and the Comstock Pumping Association, an association composed of the several mining companies, by terms of which the electric company is to construct a power plant and to sell power to the mines, and whereby the Pumping Association agreed to advance one hundred thousand dollars as a bonus to

The electric company's dam is situated close to the mills of the Floriston Pulp & Paper Company, at Floriston, Cal., on the main line of the Central Pacific Railway. It is of timber crib construction, rock filled and sheathed with double two-inch plank-ing. The main structure is 142 ft. in length and 7 ft. in height, the cribs at each end being built up about 10 ft. higher as a protection to the abutments in time of high water. The head gates are set into the head of a canal on the north bank of the river above the dam. They consist of five openings separated by walls of 12 x 12 timbers built up into cribs above and at the sides. The gates proper are of wood sliding in angle-iron guides, and are operated by means of screw stems and hand wheels.

The canal is about 600 ft. in length and 20 to 100 ft. wide, forming a settling pond, and providing for the water a means of quiet entrance into the flume. It was originally the old river bed, requiring but little excavation to make it fit for

* Reprinted through the courtesy of the Electrical World and Engineer.

use as above described. At the lower end the water flows through a finger-bar screen into the head of the flume, which is 28 ft. wide at this point, converging in a length of 40 ft. to its normal size. The finger-bars, scour gate and spill-way are maintained in place by crib work similar in construction to that in the dam.

The flume is about 8,600 ft. long and is 6 ft. 8 in. by 10 ft. in the clear, of native pine, carrying 300 cu. ft. of water per second, with a depth of 6 ft. in the flume. The boxes are 12 ft. in length, supported on bents spaced 16 ft. centres, with two sets of four intermediate posts. At two points on the flume line are spill gates set in the sides of sand boxes below the bottom of the flume. In case of damage to any part of the structure, the water may be turned out at once through the nearest set of spill gates without the delay necessary to operate the head gates at the dam. For 200 ft. back from the penstock a spill flume 5 ft. 8 in. wide is built at the side of the main flume on a heavy grade to take the spill water when the penstock gates are closed. The penstock is of pine, 36 ft. long by 21 ft. wide, stayed with three-quarter-inch iron rods. Inside it is divided by a bulkhead into two compartments, from one of which two pipe lines lead. The flow of water to each pipe is controlled by three wooden gates in the bulkhead, operated by hand wheels from a platform above.

Water flows to the wheels through two lines of wooden stave pipe, 72 ins. inside diameter and 160 ft. long. The staves are of redwood, varying in length from 10 ft. to 24 ft., and bound together by means of five-eighth-inch round steel bands. Where joints come in abutting staves, a metallic tongue of one-eighth-inch band iron is fitted into the ends of both. A few feet from the power house the wooden stave pipes are wedge-jointed to steel pipes riveted onto the wheel cases.

Below the penstock, close to the river bank, stands the large brick power house, the length of which inside is 88 ft. and width 31 ft., the proportions, from an architectural point of view, being relieved by a hip in the roof, projecting toward the river. The foundations and tail races are of concrete and the roof of corrugated, galvanized iron, supported on steel trusses and wooden purlins. The interior is well lighted by windows of ample size. All low potential cables are carried in 6-in. ducts of glazed sewer tile, embedded in the concrete floor, and the station is served by a 12-ton hand crane supported on heavy I-beams running the length of the building on brick pilasters projecting from the walls and spaced 10 ft. centres. The tail races are 18 ft. in depth, with roofs formed by springing concrete arches between steel I-beams, and concrete floors protected by heavy planking 6 ft. below the level of minimum water in the river.

The main water wheel equipment consists of two pairs of 27-in. horizontal McCormick turbines, each pair capable of developing 1,400 horse-power at 400 r. p. m. under a working head of 84½ ft. The main body of the wheel casing is of heavy plate steel, and the buckets of the runners are of cast-steel with heavy bands around them. To each wheel case are riveted heavy cast-iron brackets, the bases of which are planed to fit similar brackets on the supporting I-beams. Each pair of turbines discharge into a cast-iron draught box, in the centre of the casing, to which is riveted a single draught tube. The tubes taper in about 20 ft. of length from 54 in. to 72 in. at the lower ends and reach tail water at an angle of 45 degs.

Each set of turbines is provided with a type "B" Lombard governor, operating the gates, and also a Ludlow balanced valve operated by a wire rope passing over sheaves, one mounted on the shaft of one of the gates, the other on a short countershaft. The lever operating the Ludlow valve is placed between

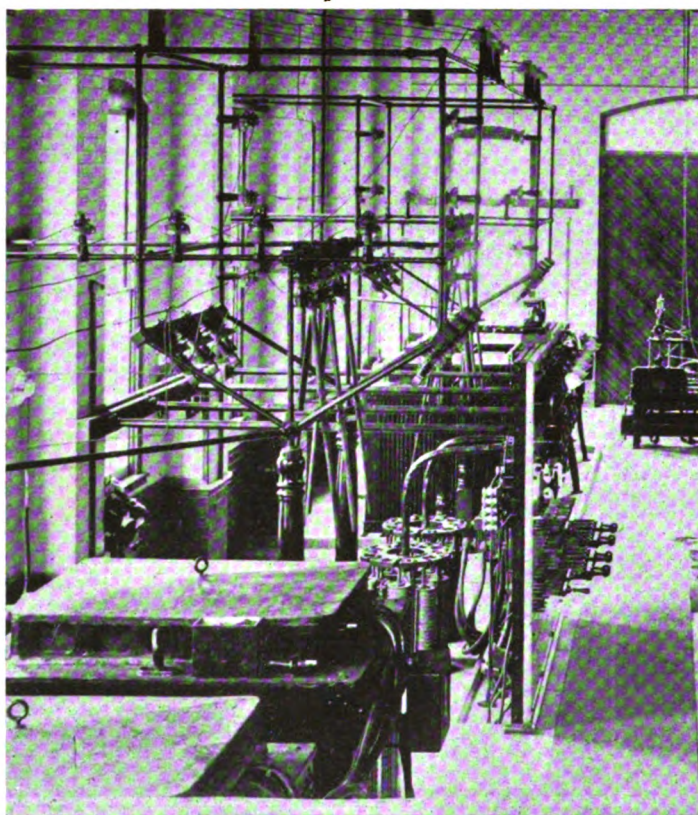
sheaves, and the wire rope fastened to it in such a manner that the revolution of the gate shaft in opening or closing the gate, closes or opens the valve in the opposite direction, thus maintaining an approximately constant velocity of flow in the pipe lines, whatever variation of load may be taking place. The valves discharge into the tail races of the wheels, and are connected to the wheel casing by a short length of steel pipe. At first sight this arrangement may appear wasteful, but in reality, since no storage of water is necessary, were the water not wasted through the valves at time of light load, it would merely spill over the flume or dam. The great gain in regulation due to constant velocity can only be appreciated upon considering the time consumed in overcoming the inertia of the large mass of water in the pipes.

To each set of wheels is coupled one 750-KW Westinghouse three-phase, 500-volt generator, the generators themselves being so arranged that they can readily be direct connected by a rigid coupling; thus both may be driven by one wheel set. The flexible couplings between generator and water wheel are of a type designed some years ago by the electric company's engineers, and are now largely in use in California. They consist of disks keyed on the shafts of the generator and wheel, each disk having four steel pins. The pins on the two flanges are connected

through leather links, the coupling, as a whole, forming a most satisfactory means of flexible connection.

The exciters—two 22½-kw machines of the multipolar type—are driven by separate turbines at 975 r. p. m. Either one has sufficient capacity to excite the fields of both generators. The exciter turbines are connected by a short length of pipe to the casings of the large wheels and discharge into their respective tail races.

The low potential switch-board is of the usual type, consisting of one exciter panel and two generator panels with the necessary instruments and switches to permit the single or multiple operation of both exciters and generator fields and the operation of each generator with either or both sets of three oil insulated, 500 to 22,000-volt transformers; or of the two machines in multiple on either or both sets. The leads from the high-tension side of the transformers run directly up overhead to the high potential switches, known as the Masson type of switch, and consisting of a framework of gas pipe to which pins and glass insulators are secured. The handles of the switches are of wood enclosing a fuse which connects the copper terminal at the extreme upper end of the



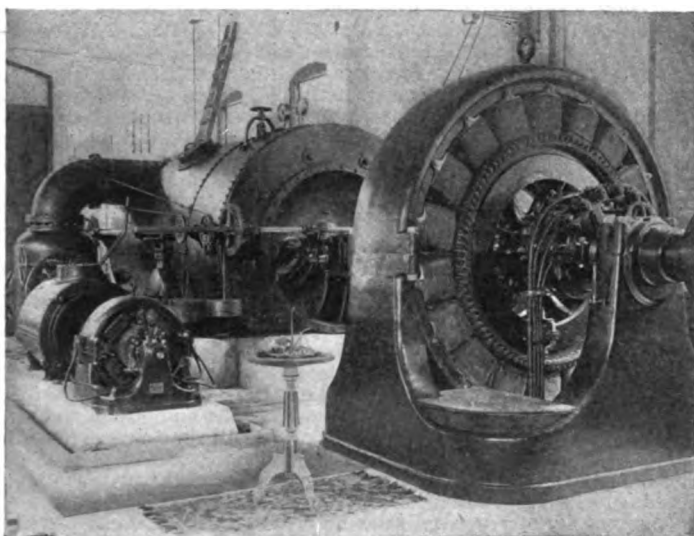
HIGH-TENSION SWITCHES.

handle to the contact jaw secured to the wood near the lower end. The opposite contact clip is secured to the bottom of a pin screwed into a glass insulator fastened to the iron framework. Thus all the high potential wires are run on glass insulators only, the jaws on insulator and handle serving to make and break the circuit. The switches are so arranged that either or both sets of transformers may be connected to either side of the double three-phase transmission line, or both sets may be operated in multiple on either or both circuits.

From the high-tension switches and lightning arresters, the two circuits are run through openings high up in the power house wall, under the gable, directly to the first pole of the transmission line. The poles are of redwood, 11 ins. × 11 ins. at the butt, 7 ins. × 7 ins. at the top and 30 ft. long, carrying two cross arms and two brackets for telephone wires. The lower cross arm carries four No. 4 B. & S. gauge copper wire on oil treated eucalyptus pins and Locke insulators, while the upper arm carries the third wires of each circuit. Transpositions occur at intervals of 144 poles. The line from power house to sub-station traverses rather a rough country, and for the greater part of the 33 miles the poles are placed 130 ft. apart. The full load line loss at

22,000 volts with the two circuits in parallel is slightly in excess of 10 per cent.

In view of the fact that the Consolidated California & Virginia shaft demands the maximum amount of delivered power, the sub-station at Virginia City is situated close to its works. Here current is delivered to two sets of three transformers, and distributed to the switchboards at the various mines at 2,250 volts, three-phase. The building is 50 ft. $\times$ 24 ft., of corrugated, galvanized iron, containing a bedroom, storeroom, and office, beside the room necessary for operating the station. The high-tension switches are of the same type and arranged in the same way as those at the power station. The low potential, or distributing switchboard, is of white marble in six panels, two of which



ONE OF THE GENERATING SETS.

are receiving, and four feeder panels. Instruments and switches are arranged in such a manner as to maintain the maximum flexibility of operation, which is a feature at the power station. To meet the conditions of measurement of delivered power imposed by the contract, as above stated, a special form of recording wattmeter was designed. It consists essentially of two indicating wattmeters, the moving parts being mounted on the same shaft, which is provided with an arm with platinum point. A disk of sensitized paper, already spaced and ruled, is rotated by clockwork between the platinum point and a metal plate, the continuous record being obtained by means of an electrostatic spark passing through the paper. In order to produce a record that will show definitely the highest two-minute load reading, which is the only part of the record required in determining the power to be paid for, the paper disk is made fourteen inches in diameter and rotates once an hour for twelve hours, the highest peak for a period of two minutes being readily determined.

The 2,250-volt distribution system from the sub-station at Virginia City is similar in construction to the transmission line. It consists of four circuits of insulated copper wire, the longest of which is two miles. The loss between any of the mines and the sub-station in no case exceeds 4 per cent.

The application of electric power at the mines is being made as rapidly as the necessary apparatus can be obtained. Electric hoists will be installed, using the balanced tail-rope system driven by direct geared 200-h. p. motors. Air compressors are belt driven, and provided with an automatic by-pass valve on the cylinders, controlled by the air pressure of the receivers, and so arranged that the by-pass valves are either full open or closed, the speed of opening or closing being adjustable.

Current for the underground stations is carried down the vertical shaft of the Consolidated California & Virginia to the 1,750-ft. level by means of a three-conductor lead-encased cable protected by a steel wire armor.

A 100-ton mill, with two sets of grinders and three sets of concentrators is equipped with six induction motors, one for each set of grinders, concentrators, and the rock breaker. Ore from the Gould & Curry mine is brought to the mill by a small direct current haulage equipment, to which current is furnished by a 220-volt direct current generator belt driven from an induction motor.

Plans are being prepared by Mr. Leon M. Hall, engineer for the Comstock Pumping Association, for an extensive electric pumping equipment to take the place of the jet pumps now in use.

Construction work on the Truckee River General Electric

Company's plant was commenced on Jan. 2, 1900, and current delivered in Virginia City for the first time on Sept. 29, regular service being started on Oct. 20.

The Engineering Offices, of San Francisco, had in charge the entire engineering work connected with the design and installation of the plant, and the Pacific Construction Company were contractors for the erection of dam, flume, pipe lines, and building.

Mine Fire at Butte.

Early in November, 1900, a fire started in the Bell shaft, Butte, Montana. In an effort to drift around the fire and thus head it off, Shift-Boss Griffin and six men, while working about 300 feet from the foot of the Bell hoist, were, on December 7, 1900, overcome by the gases given off. As the men did not come to the surface for lunch a volunteer relief party was organized and sent down the shaft. They also were overcome, and a second party was organized and provided with Vajen-Bader helmets. Thus equipped and working under the direction of Fire Chief George Tapp and Superintendent James Higgins, this second party and others organized later succeeded in reaching the twenty-one men in the mine who had been overcome. Happily no fatalities occurred, as fresh air, coffee, whiskey, and rolling restored all of those who had been overcome by the noxious gases in the mine.

The foregoing instance is another argument in favor of having some means at hand, as part of the equipment of every mine, with which succor can be extended to those unable to assist themselves in like emergencies. To accomplish the proper results in constructing a protection which possesses all the attributes of its design, science plays not a small part, as every contingency which might arise must be provided for. It is essential that this protection be not an incumbrance in any sense, but it must permit the duty present to be disposed of with undivided attention; freedom in action, breathing, seeing, hearing, etc., being paramount requisites.

Explosions being of very frequent occurrence, provision should be made to withstand forces arising from such causes and to insure the safety of the person or persons protected. Lightness of weight must also be considered, combined with the quality to resist fire and the possibility of quick adjustment.

Only those who have had the fearful experience of fighting fire underground or have been confronted with bad airs or smoke can form an adequate idea of the horrors encountered in such efforts. Therefore, a device which counteracts the deadly effects



and permits free and comfortable ingress with safety to otherwise menacing surroundings, is an article essential to the equipment of every mine. The helmets or head protectors used at the Bell mine were purchased of the Vajen-Bader Co., of Indianapolis, Ind., who claim for their product all the requirements in such an article, perfected after a lifelong study of the subject. Their output goes all over the world, and there is scarcely a country on the globe where they cannot be found. Three of the greatest governments have adopted them, viz.: England, United States, and Russia, whose purchases for a time tested the capacity of their factory.

This fact, together with the endorsements of the many well known mining corporations all over the world constantly using them to advantage, and with a wonderful showing of lives and property saved, leaves no doubt that their merits are fully established.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Bituminous Mine Foreman's Examination, 2nd, 5th, and 9th Districts, Held in Greensburg, Uniontown, and Connellsville, Pa., Jan. 2nd and 3rd, 1901.

PRELIMINARY QUESTIONS.

A.—Are you a naturalized citizen of this Commonwealth?

B.—If a naturalized citizen produce proof of your citizenship.

C.—How many years practical experience have you had in the workings of bituminous mines in this State?

D.—State when, at what mines, and by whom employed, and in what capacity you have had practical experience in mining in the bituminous mines in this State.

E.—Have you testimonials of character?

Ques. 1.—If you had a double-acting pump running ninety (90) feet per minute, size of pump ten (10) inches in diameter, how much water per hour would it discharge, and what should be the size of the suction and discharge line to allow this pump to work at its best?

Ans.—Assuming an efficiency of 85% for the water end of this pump, we have for the quantity of water discharged per minute

$$G = \frac{.85(.7854 \times 10^2 \times 90 \times 12)}{231} = 312 \text{ gal.}$$

To obtain the diameter of the suction and discharge pipes for a pump, it is customary to estimate upon a velocity of 200 feet per minute in the suction pipe and 400 feet per minute in the delivery pipe. Then, we have,

$$\text{suction pipe, } d_1 = \sqrt{\frac{231 G}{200 \times 12 \times .7854}} = .35\sqrt{G},$$

or, in this case, $d_1 = .35\sqrt{312} =$, say 6 in.

Likewise for the discharge pipe, $d_2 = .25\sqrt{G}$,

or, in this case, $d_2 = .25\sqrt{312} = 4.41$, say 5 in.

Ques. 2.—Does an increase or decrease of the pressure of the atmosphere affect the volume of air passing through a mine? Explain.

Ans.—In furnace ventilation an increase or decrease of atmospheric pressure does not affect perceptibly the volume of air passing through a mine. Any increase or decrease of atmospheric pressure will cause a corresponding increase or decrease of the density of the air, but this does not appreciably affect the frictional resistance incident to the passage of the air current through the mine. In fan ventilation the increase or decrease of the density of the air caused by a change of atmospheric pressure, increases or decreases the efficiency of the fan quite appreciably. If the power applied to the fan shaft remains the same, any atmospheric change that increases the density of the air causes a decrease in the number of revolutions made by the fan per minute, or a decrease of the speed of the fan; but any atmospheric change that decreases the density of the air will produce an increase in the speed of the fan. Thus, a fan making 100 revolutions per minute in dry air, temperature 60° F., bar. 30 inches, will make only 93 revolutions per minute when the temperature falls to 30° F. below zero; while at a temperature of 100° F. the same power applied to the fan will produce a speed of 103 revolutions per minute. If, however, the power applied to the fan is altered so as to maintain the speed of the fan constant, any atmospheric change that increases the density of the air will likewise increase the quantity of air delivered, and any atmospheric change that decreases the density of the air will likewise decrease the quantity of air delivered. Thus, a fan delivering 80,000 cubic feet of dry air per minute at a temperature of 0° F. will deliver 81,822 cubic feet when the temperature falls to 30° F. below zero, at the same speed; or 75,365 cubic feet when the temperature rises to 90° F., at the same speed (bar. 30 inches). Or again, a fan delivering 76,000 cubic feet of air per minute at a temperature of 60° F., bar. 29 inches, will deliver 77,700 cubic feet of air at the same speed of the fan and temperature of the air when the barometer stands at 31 inches. These figures show the effect of atmospheric change to be considerable in fan ventilation.

Ques. 3.—What dangers and difficulties are often encountered from a mine creep?

Ans.—A mine creep is not always attended with immediate danger, much depending upon the rapidity with which the weight comes on. At times the action of the creep is very sudden and severe. Pillars are crushed and heavy falls occur in the rooms and entries, which often completely close the workings over large areas or render their working extremely dangerous. The difficulties encountered from this cause are the maintaining of the rooms, and particularly the entries in a safe condition. If the action of the creep is at all violent the working places are usually abandoned as unsafe, and every effort is made to cause a fall in the rooms and working places so as to prevent the destruction of the entries.

Ques. 4.—Describe in detail the duties of a mine foreman as prescribed in the mine law?

Ans.—Art. 6 of the Bituminous Mine Law of Pennsylvania prescribes that the mine foreman shall devote all of his time to his several duties at the mine when the latter is in operation, or in case of necessary absence shall authorize an assistant to act for him. He shall keep a careful watch over the ventilating apparatus, and the airways, travelingways, pump, pump timbers, and drainage in the mine. He shall oversee the work of the miners as far as it relates to the security of their working places; he shall see that all dangerous coal and slate and rock are taken down or made secure in the rooms and travelingways and haulways, and shall provide a sufficient quantity of props, caps, and timbers of suitable size, and shall deliver the same in the working places of the mine when notified by the workmen that these are required. He shall attend to making the proper cut-throughs in all room pillars and entry pillars, and shall see that the ventilating current is properly conducted through these by means of canvas or other doors placed at suitable points in the entries. He shall measure the air current at least once a week at the inlet and outlet, and at or near the faces of the entries in the mine, and shall keep a record of such measurements. He shall require the workmen to use locked safety lamps only, when and where required by law. He shall give prompt attention to any places reported to him as dangerous by any person working in the mine, and shall visit and examine every working place in the mine at least once every alternate day when the mine is at work. He shall each day countersign the report entered by the fire boss in the book kept at the mine for that purpose, and shall himself each day enter and sign, in a book provided by the mine inspector, a report of the condition of the mine, clearly stating any danger that has come under his observation during the day, and also whether he has a proper supply of material on hand for the safe working of the mine, and whether all the requirements of the law are being strictly complied with. He shall once each week enter in said book, in ink, a true record of all air measurements required by law. In case no superintendent is employed at the mine of which he has charge, the mine foreman shall perform the duties required by law of the superintendent, maintaining a full supply of all materials and supplies required to preserve the life and safety of the employees, or withdrawing the men from the mine or part of the mine affected until such supplies of material are received. He shall see that all stoppings in airways are properly built, and that the entries at such places where it is necessary to apply or remove sprags or brakes from mine cars shall have a clear level width of not less than 2½ feet between the side of the car and the rib of the entry. He shall direct that all miners undermine the coal properly before blasting it, and that blasting shall be done only at such hours as he shall direct. He shall order the miners to set sprags under the coal when necessary for safety while undercutting, the sprags to be set at distances not exceeding 7 feet apart. He shall not allow improper drawing of pillars. He or his assistant shall superintend the relighting of the furnace in mines generating firedamp. In case of accident to the ventilating machinery he shall immediately order the men to withdraw from the mine and not to return to their work until the ventilation has been restored in the mine. He shall see that all dangerous places are properly fenced off, and danger signal boards hung in a conspicuous position upon such fencing. He shall visit all the accessible portions of old workings as often as is necessary to assure himself of their safe condition. He shall provide a book or sheet in some convenient place, upon which each miner can designate his number, the quantity of props required, their approximate length, and the number of caps and timbers needed. The sheet for each day shall be dated and preserved 30 days from that date. He shall see that any person engaged in the mines is given medical or surgical treatment, if the same is needed. He shall report monthly to the mine inspector of the district, upon a blank furnished by the inspector for that purpose, all accidents resulting in personal injury.

Ques. 5.—What, in your opinion, is the best system of mechanical haulage to suit all conditions? Give reasons.

Ans.—This is purely a matter of opinion, since no one system of mechanical haulage is strictly suited to all conditions. Where electric haulage, or compressed air haulage has proved economical and advantageous in some mines, rope haulage, on the other hand, has proved equally successful in other mines. In the operation of a large plant, and especially where machines are run at the working face, compressed air motors may often be used for haulage to great advantage, in connection with the use of compressed air for the machines at the face. The use of compressed air is also advantageous in gaseous mines. The use of electricity possesses a great advantage in the flexibility of the system, as the wires conducting the current are easily installed and changed to suit the varying conditions in the mine. Both of these systems, however, require the installing of an expensive plant at the surface for compressing the air or generating the electricity they require. In this regard rope haulage has the advantage; and inasmuch as some form of rope haulage can nearly always be installed, whatever the conditions in the mine with respect to the inclination of the seam, gas, character of roof and floor as affecting the security of the mine passages, this would seem to be the system that would best answer the question. The gaseous condition of the mine will often render the adoption of an electric system of haulage inadvisable. In like manner the security of the mine passages due to the character of the roof and floor, and other conditions relative to the mine, often render the adoption of a compressed air system of haulage, also, inadvisable. Highly inclined seams render both of these systems of haulage by electric or compressed air motors impracticable, and for these reasons rope haulage is the only system of mechanical haulage that can be said to be adaptable to all conditions. It must be clearly understood, however, that although adaptable in nearly all cases, it is very often not the most economical nor convenient system.

Ques. 6.—If the ventilating power be insufficient and cannot be increased, how would you increase the volume of air in a mine?

Ans.—This question is fully answered in reply to Ques. 12, page 87, MINES AND MINERALS, September, 1900.

Ques. 7.—What, in your opinion, causes gob fires, and what methods would you adopt to decrease the liability to them?

Ans.—The cause of gob fires is the gradual heating of the gob due to spontaneous combustion taking place when fine coal and slack is mixed with the gob. The moist heat of the strata promotes distillation of gas from the fine coal, which permeates the waste and assists in the ignition of the coal. The oxidation of pyrites, when present in the coal, also increases the tendency to fire. To decrease the liability to gob fires, all fine coal and slack should be loaded out from the working face, and the miners not permitted to throw this back in the gob. The tendency to heat and fire is greater in some coals than in others. Also, a free circulation of air should be maintained at the working face. See Coal and Metal Miners' Pocketbook, 6th edition, page 291.

Ques. 8.—What change, if any, in your opinion, could be made by mine officials in order to reduce the number of mine accidents in and about mines of the present day?

Ans.—A strict compliance with the mining laws of the several states would very largely reduce the number of mine accidents. The mine foreman should give his prompt attention to all dangerous places in and about the mine as soon as his attention is called to the same. He should not only instruct the miners in reference to the proper timbering of their places, but should see that this work is done at once and the place made secure, or else should compel the miner to leave his place until such work can be performed as is necessary to make his working place safe. A change in discipline, where such is necessary, is the most important change, to our mind, that can be made with a view to the reduction of the number of mine accidents.

Ques. 9.—What is the area of an airway where the breadth of the top is 5 feet 9 inches; middle, 7 feet 9 inches; bottom, 7 feet 6 inches; height, 9 feet?

Ans.—For the area of the upper half of the airway, we have,

$$\frac{5.75 + 7.75}{2} \times \frac{9}{2} = 6.75 \times 4.5 = 30.375 \text{ sq. ft.}$$

For the area of the lower half of the airway, we have,

$$\frac{7.75 + 7.5}{2} \times \frac{9}{2} = 7.625 \times 4.5 = 34.3125 \text{ sq. ft.}$$

Total area of airway = $30.375 + 34.3125 = 64.6875 \text{ sq. ft.}$

Ques. 10.—How would you develop a new mine to obtain the best results from machine mining, and what machine would you prefer, and why?

Ans.—The mining of coal by machines is so largely dependent upon the conditions existing in the mine relative to the character of the coal, and of the roof and floor of the mine, and the inclination of the seam, that it would be difficult to describe such a development of a mine as will produce the best results in the mining of the coal by machines. Assuming, however, that the

seam is flat and has a good roof and floor, the best results are obtained when the rooms can be arranged in groups or panels so as to present one continuous breast. From 4 to 10 or 12 rooms may thus often be arranged to be mined as a single breast, and less time is then lost in moving the machine from one breast to another. As much room should be provided at the working face as will allow of the easy movement of the machine along the face. Where the conditions of the roof or floor are such as to necessitate a cramped working of the machine at the face, much loss of time results. In the opening of a new mine particular attention should be given to the direction in which the breasts are driven with respect to the cleats of the coal, in order to obtain the best results in regard to the breaking of the coal. The general type of machine to be preferred depends upon the nature of the coal, and to some extent the nature of the roof and floor. Where the coal is soft and regular and mines easily, and the roof and floor are such as to afford the necessary room for operating the machine, the type known as the chain-cutter machine is preferable. Whenever the coal is hard, irregular, and brittle, and especially if the seam contains sulphur balls, the type known as the pick machine is better adapted for use. The pick machine requires less space for its operation, and is more readily moved about from place to place, and for this reason is better adapted where the roof is poor. (See Coal and Metal Miners' Pocketbook, 6th edition, page 336.)

Ques. 11.—What effect would timber in a roadway have in the ventilation of a mine, and in what part of the airway would it last the longest, and why?

Ans.—The effect of timber, as regards ventilation, is to reduce the sectional area of the airway and increase its resistance, thereby decreasing the quantity of air in circulation for the same ventilating power. In general, timber will last the longest upon the return airway, for the reason that the air upon this airway is always moist. Subjecting the timber in an airway to an alternate moist and dry atmosphere greatly hastens its destruction. Timber will rot the quickest at that point of an airway where a cold intake current comes in contact with the moist air of the mine flowing from other workings or parts of the mine, and having a higher temperature. The moist mine air, cooled by contact with the intake current, deposits its moisture upon the mine timbers and results in a fungus growth that rapidly destroys the timber.

Ques. 12.—Does a regulator increase the friction of air in the mine, and in what manner?

Ans.—Any change made in a circulation, to produce a proportionate division of the air, or to produce any division other than the natural division, will result at once in an increase of the unit of ventilating pressure for that split in which it is desired to circulate a larger quantity of air than it receives by the natural division of the current. Since an increase of the pressure and quantity of air circulating in one of the airways is accomplished by means of a regulator, it is true that the regulator causes an increase of ventilating pressure in that airway or split. In the other airway, however, if the regulator is placed at the mouth of the split, there will be a reduction both of the unit of ventilating pressure and the quantity of air passing. The question of the increase of friction for the entire mine is one dependent wholly upon the rubbing surfaces in the two splits and the division of air accomplished by the regulator, and may prove to be an increase or a decrease of friction. There are two general methods of producing proportionate division by the use of regulators (see Answer to Ques. 14, page 87, MINES AND MINERALS, September, 1900).

Ques. 13.—If you have 10,000 cubic feet of air passing into a mine, how will this current divide itself between two splits as follows:

Split A, 4 feet $\times$ 12 feet, 6,000 feet long;
Split B, 6 feet $\times$ 8 feet, 10,000 feet long.

Ans.—Assuming that the pressure at the mouth of each of these splits is the same, we find the relative potential* for pressure

for each split, as given by the expression $a\sqrt{\frac{a}{l}}$, a being the area, l the length, and o the perimeter of the airway and we have

For split A, $48\sqrt{\frac{48}{6,000 \times 32}}$

For split B, $48\sqrt{\frac{48}{10,000 \times 28}}$

Canceling common factors in these relative potentials, we have,

For split A, relative potential, $\sqrt{\frac{1}{3 \times 8}} = \frac{1}{\sqrt{24}} = .2041$,

For split B, relative potential, $\sqrt{\frac{1}{5 \times 7}} = \frac{1}{\sqrt{35}} = .1690$

Total relative potential, $= .3731$.

*See Coal and Metal Miners' Pocketbook, 6th edition, page 368, for explanation of "Potential."

Then since the quantity passing in each airway is proportional to the potential for that airway, it follows that the quantity in either airway is to the total quantity in circulation, as the potential for that airway is to the sum of the two potentials, and we write the proportion,

$$\text{Split } A, .2041 : .3731 :: x_1 : 10,000,$$

$$\text{Split } B, .1690 : .3731 :: x_2 : 10,000.$$

And solving these proportions, we have,

$$x_1 = \frac{2041}{3731} \times 10,000 = 5,470 \text{ cu. ft. per min.}$$

$$x_2 = \frac{1690}{3731} \times 10,000 = 4,530 \text{ cu. ft. per min.}$$

QUES. 14.—Show by sketch the best method of drawing ribs 30 feet thick where the strata is 250 feet; also explain the various reasons for your method, and while you are busy explain why some ribs of the same thickness are more difficult to extract than others.

ANS.—Assuming a flat seam of, say 6 feet in thickness and lying 250 feet below the surface, the best method of drawing ribs 30 feet thick would be to maintain roadways *R, R* (Fig. 1), upon each side of the rib, giving to each miner 15 feet of the rib to draw back. As shown in the figure a shot should first be taken

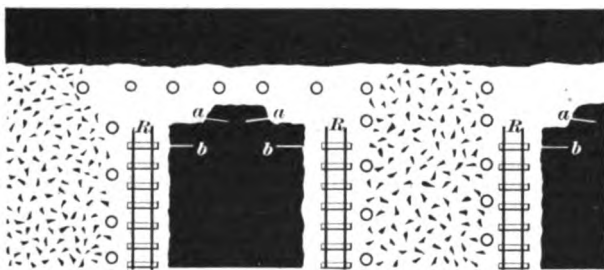


FIG. 1.

off of each rib next to the roadway after the manner of working a loose end. When this is cleaned up second shots *a, a* are placed one on each side to extract the center of the rib. Two shots on each side of the rib should be sufficient to bring the miners together. When the coal is loaded and the roof made secure by timbers, shots *b, b* are again placed in the rib next to the roadway as before. It should be the aim to draw back the several pillars uniformly, and to keep the ends of the pillars square, so that the roof pressure will not bear too heavily upon any of them. The timbers should be drawn a short distance behind the pillar working so as to induce a fall.

The reason that some ribs of the same thickness are more difficult to extract than others is owing very largely to the size of pillars left, relative to the character of the coal, depth of cover, and nature of the floor and roof, and the method adopted for their extraction. Where the pillars are thin and the roof pressure considerable, or where the coal is soft, the pillars become crushed and the coal is then not only difficult but dangerous to extract. Where the pillars are crushed and creviced, blown-out shots are liable to occur in their working, since the energy of the powder is exerted upon the air through the crevices rather than upon the coal. Undermining, in pillar work, should be done with caution.

QUES. 15.—A fan 20 feet in diameter, running at a speed of 40 revolutions per minute, produces 50,000 cubic feet of air, with $1\frac{1}{4}$ inches of water gauge, what would be the quantity of air passing and water gauge, if the number of revolutions were increased to sixty, and what will the equivalent orifice be?

ANS.—The usual method is to assume the quantity of air in proportion to the speed of the fan, and the pressure proportional to the square of the speed. This would give 75,000 cubic feet of air, and $3\frac{1}{4}$ inches water gauge at 60 revolutions per minute. In practice, however, this is not obtained, but the quantity is proportional to the fifth root of the fourth power of the speed, and the water gauge proportional to the fifth root of the eighth power of the speed; which gives for the quantity and water gauge at 60 revolutions per minute:

$$\text{Quantity} = \sqrt[5]{\left(\frac{60}{40}\right)^4} \times 50,000 = \sqrt[5]{1.5^4} \times 50,000 = 69,160 \text{ cu. ft. per min.}$$

$$\text{Water gauge} = \sqrt[5]{\left(\frac{60}{40}\right)^8} \times 1.5 = \sqrt[5]{1.5^8} \times 1.5 = 2.87 \text{ in.}$$

The equivalent orifice of the fan cannot be determined from the data given; but that of the mine is obtained as follows:

$$a = .00038 \frac{q}{\sqrt{h}} = \frac{.00038 \times 50,000}{\sqrt{1.5}} = 15.513 \text{ sq. ft.}$$

QUES. 16.—What is the general efficiency of a fan? If the horsepower of an engine is 40 and the water gauge 1.5 inches, what quantity of air would you expect to get?

ANS.—The efficiency of ventilating fans varies much. For an ordinary fan the mechanical efficiency may be generally stated as, say 60 per cent. of the rated horsepower of the engine. Under favorable conditions, especially if the fan is proportioned to the work which it is performing, an efficiency of 80 per cent. of the horsepower of the engine is often obtained. Assuming an efficiency of 60 per cent., if the engine is rated at 40 horsepower, the horsepower effective upon the air will be $40 \times .60 = 24 \text{ H. P.}$ Then if the water gauge reading is 1.5 inches, the quantity of air in circulation is given by the formula

$$q = \frac{24 \times 33,000}{1.5 \times 5.2} = 101,539 \text{ cu. ft. per min.}$$

QUES. 17.—What are the dangers of the use of electricity in mines, and what methods would you employ to prevent accidents therefrom?

ANS.—Among the dangers arising from the use of electricity in mines may be mentioned: (1) Incandescence of the conducting wire; (2) sparking occurring in the motor or caused by a broken circuit; (3) the producing of a voltaic arc between two carbon terminals. Each of these occurrences would be dangerous in a gaseous mine. There is also the danger of men and mules coming in contact with a conducting wire and receiving shocks which are more or less severe. To avoid these dangers as far as it is possible, an alternating current should be used in preference to a continuous current. Large size motors are safer than the smaller types, because any variation in the load affects them less. Carbon brushes should be used because they have less tendency to spark. Lead or tin safety fuses should not be employed, but fusing wires protected by a shunt should be substituted in their place. The conducting wire should be securely fastened to the roof in such a position that a person or mule will not be liable to come in contact with it while walking in the entry. Strict regulations should be made and enforced in relation to the handling of any of the switches or wires by persons not authorized to use them, and as far as possible the traveling of men and mules should be prohibited on entries where electric wires are hung (see also *Danger from Electric Appliances*, MINES AND MINERALS, July, 1898, page 559).

QUES. 18.—How would you timber a roadway with a soft or wet bottom, and show also with a sketch how you would timber a road subject to side pressure?

ANS.—In an airway where the bottom is soft or wet the posts of the framing timbers should stand upon sills. The sills employed for this purpose often run longitudinally along each side of the entry, as shown at *a*, Fig. 2, or cross sills may be used

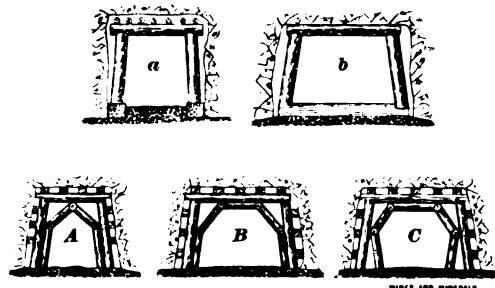


FIG. 2.

as shown at *b*. Where the bottom is very soft and miry the road should be corduroyed by laying timbers or cross ties close together under the track. It is important to drain such roadways well.

Fig. 2 *A, B*, and *C* shows the methods employed for timbering roads subject to side pressure. Where the sides and roof are frail and tend to crumble, lagging is placed behind the framing.

QUES. 19.—On entering upon your duties as mine foreman of a colliery that has been in operation some time, what would you consider to be your duty in order to make a reputation for yourself and do justice to your employer? What stand would you take with your men and what would be your first duty upon taking charge?

ANS.—In order to make a reputation for himself and to do justice to his employer, it would be the aim and purpose of a man to reduce the running expenses of the work in his charge, and to increase the quantity and quality of the output as far as practicable. It would be his endeavor to produce the largest output at a minimum cost. I would treat all my men in a fair and unbiased manner, and have them understand that I expected a day's work for a day's pay. I would also try to improve the general feeling among the men in charge of the different departments and to bring them into harmony of action. I would systematize the work wherever there appeared to be loss of time or labor.

I would exact economy of material and labor from all men under my charge. My first duty upon taking charge would be to thoroughly acquaint myself with the details of the work and the abilities and capacities of the several men for performing their special work, and to investigate the amount of work done by each man. I would try to improve the methods of operating, with a view to reducing the expense per ton of output. I would also try to improve the machinery in use, with respect to the efficiency of each machine.

Ques. 20.—How can you ascertain, by the barometer, the pressure of the atmosphere on the earth's surface per square inch and per square foot? Will it indicate the friction of air in mines, and why?

Ans.—Since the atmospheric pressure balances the mercury column of the barometer, the weight of the mercury column indicates the exact pressure of the atmosphere upon an area equal to the sectional area of the column. Hence, to obtain the pressure of the atmosphere per square inch we must calculate the weight of a mercury column whose height is equal to the height of the barometer and whose sectional area is one square inch. One cubic inch of mercury weighs .49 pound; hence, if we multiply .49 by the height of the barometer in inches, we will obtain the pressure of the atmosphere per square inch. Thus, if the barometer stands at 30 inches the atmospheric pressure per square inch is $.49 \times 30 = 14.7$ lb. per sq. in. The pressure per square foot is found by multiplying the pressure per square inch by 144, since there are 144 square inches in one square foot. Thus, when the barometer stands at 30 inches the atmospheric pressure per square foot is $14.7 \times 144 = 2,116.8$ lb.

We suppose in this question it is intended to ask if the barometer can be used for measuring the ventilating pressure in a mine. The barometer measures the total pressure, or the pressure above a vacuum, and cannot be used to ascertain the ventilating pressure, which means the pressure producing ventilation in the mine, or the amount the pressure in the intake airway exceeds that in the return. The ventilating pressure is always the difference between two pressures, while the barometric pressure is the total pressure due to the weight of the atmosphere.

Ques. 21.—To increase the greatest possible safety, what means would you adopt when firing shots in a seam of coal that gives off explosive gas?

Ans.—In order to secure a maximum of safety when firing shots in a gaseous seam of coal, every precaution should be taken to avoid the ignition of the gas. Under these conditions all shots should be fired by a duly authorized and experienced person. The face should first be carefully examined for gas. The use of fuses should be prohibited. Touch squibs have been used with good success in gaseous seams, these being ignited by a piece of touch paper. When a large amount of gas is being given off from the bore hole the best mode of firing a blast is by using two blasting barrels; laying one barrel in the hole before charging, and inserting the other in the powder cartridge far enough to tie securely. Then tamp or stem lightly for a few inches, taking care that your tamper works smoothly, and when ready, use safety squibs, known among miners as *touch squibs*. Insert the squib, after examining, in the barrel leading to the powder and light or touch with a separate piece of touch. The other barrel carries the gas away and should be from 8 to 12 inches longer so as to protrude from the hole farther than the one that leads to the powder.

Ques. 22.—How would you attempt to overcome a mine fire already in operation?

Ans.—Assuming that the fire is located in an airway or other passage of the mine, it must be fought from its intake end, since it would be impossible to approach it in any other way. Pipes or hose are quickly laid in the entry so as to conduct water from the pumps to the scene of the fire, and the pump pressure is increased to its maximum. When convenient, steam has often been used to good advantage. All efforts to arrest the fire by these means proving unsuccessful, and it being impossible to isolate the fire by building stoppings, recourse must be had to flooding the mine or such portion of it as can be shut off and filled with water. Flooding is always the last resort. If the fire occurs in rooms or chambers, it can generally be isolated by the building of fire-proof stoppings at the mouth of these openings, when it will finally smother itself. It is sometimes possible, when the fire is in the return airway, to close tightly the top of the upcast shaft after building a heavy fireproof stopping upon the intake side of the fire. When this has been done, steam is introduced into the shaft, and the fire smothered in the products of its own combustion.

Ques. 23.—If the quantity of air in the downcast weighs 18,000 pounds, the depth of the shaft being 300 feet, and the difference of the weight of air in the shaft 2,500 pounds, what will be the length of the motive column?

Ans.—Assuming that the weight of the entire air in the down-

cast shaft is 18,000 pounds, as the question states, the depth of the shaft being 300 feet, the weight of a layer of air in this shaft, 1 foot in thickness will be $\frac{18,000}{300} = 60$ lb. [We think 18,000 must

be a typographical error for 1,800, and 2,500 likewise an error for 250, since the weight of 1 cubic foot of air (temperature 60°, bar. 30 inches) is .0766, and the sectional area of the shaft under the conditions named would have to be $\frac{60}{.0766} = 783$ sq. ft. This,

however, does not affect the answer.] The difference of the weight of the air in the two shafts being 2,500 pounds, the length of the motive column which would produce the same pressure is $\frac{2,500}{60} = 41\frac{2}{3}$ ft.

Bituminous Fire Boss' Examination, 2d, 5th, and 9th Districts, Held in Greensburg, Uniontown, and Connellsville, January 4, 1901.

Ques. 1.—State your age. And are you a citizen of the Commonwealth, and how many years practical experience have you had in the workings of bituminous mines of this state?

Ques. 2.—What practical experience have you had in the bituminous mines of Pennsylvania? And in what capacity have you obtained this practical experience in mines which generate explosive gases? State at what mines you acquired such experience.

Ques. 3.—Assuming that you are a fire boss and were about to enter upon the discharge of your duty, how would you proceed to examine the mine? Explain fully.

Ans.—Assuming that the fire boss has a thorough acquaintance with the mine workings in every circumstance and detail, which is essential to the proper performance of his duties, the first step in the examination of the mine, after a careful examination and adjustment of his safety lamp at the surface, and when he has reached the shaft or slope bottom, is to proceed at once to the foot of the downcast or the main intake airway to ascertain that the air current is moving properly. In case there is any disturbance of the circulation either by the setting open of a door or the slowing down or stoppage of the fan, it is very important after the circulation has been again started to proceed with caution along the intake airway, examining every portion of the workings or cavity of the roof where gas would readily accumulate. Where such bodies of gas are found a temporary brattice should be erected in the airway to dislodge and sweep out the gas, or if the accumulation of gas is found in a room, such room should be barred off, and a proper danger signal placed in a conspicuous place at the mouth of the room to prevent any one from entering the room unwarned. In this manner a thorough examination is made of each working place in the mine, proceeding in the direction in which the air is moving, or with the current. The examination of a working place is made by slightly raising the safety lamp into all cavities where the presence of gas may be suspected. There are two general methods in use for testing for gas with the safety lamp, each method having its own particular advantage. In one of these methods the test is made with a normal height of flame; while in the other method the flame is first lowered to a small uniform height. When testing with a normal flame the percentage of gas is determined more by the total height of the flame rather than by the height of the flame cap. Indeed, it is often difficult with the normal flame to observe accurately the pale blue cap surmounting the flame. But in testing with the reduced flame the percentage of gas is determined by the height of the pale blue cap. In the former method (normal flame) the higher percentages of gas cause a waving, unsteady motion of the flame within the lamp, and as the gaseous mixture approaches the explosive limit the flame becomes a tall, waving, spindle-shaped flame often rotating in a wierd manner about the central axis of the lamp. This is just previous to the point where the lamp fills with flame. In the use of the reduced flame for testing, this waving, spindle flame is not obtained, but in its place a tall, slim, pale-blue tip appears, which is quite steady compared with the waving motion that occurs in the use of the normal flame. Both of these methods are, respectively, favorites with different fire bosses. In the use of the normal flame a better light is secured for examining the condition of the roof of the working face, but the flame is hardly as sensitive to small percentages of gas, nor is it usually considered as safe as the reduced flame in mixtures containing a high percentage of gas. When gas feeders occur in the roof particular attention should be given to determine the depth of gas at the roof.

Ques. 4.—A current of 3,000 cubic feet is at an explosive point, how much fresh air must be added to prevent a cap?

Ans.—We assume that the question refers to the current as being at its most explosive point, and that it is intended to ask, How

much pure air must be added to render the mixture in explosive? If the gaseous mixture of the current was at either of the explosive limits it would take but a slight addition of air to make it either less or more explosive, according as the case might be. To make this clear, we give the proportions of gas and air in mixtures at their most explosive point, as well as at the lower and higher explosive limits. Thus,

Higher explosive limit, 1 volume of gas, $5\frac{1}{2}$ volumes of air,
Maximum explosive point, 1 volume of gas, $9\frac{1}{2}$ volumes of air,
Lower explosive limit, 1 volume of gas, 13 volumes of air.

It is readily observed that any addition of air when the mixture is at its higher explosive limit would render it more explosive, while any addition of air at the lower explosive limit would render it in explosive. The higher explosive limit of a gaseous mixture is seldom experienced in mine workings, and is always the more dangerous condition, since a slight addition of air may occur at any time and render the mixture violently explosive.

The proportion of gas and air in the current in question being 1 of gas to $9\frac{1}{2}$ of air, or 1 of gas to $1 + 9\frac{1}{2} = 10\frac{1}{2}$ of mixture, the percentage of gas in the mixture is $\frac{1 \times 100}{10\frac{1}{2}} = 9.52$. (Exactly,

this percentage is 9.38, when the gaseous mixture is at its most explosive point. See answer to Prize Contest Ques. 574, page 508, MINES AND MINERALS, June, 1900.) Now, assuming the proportion of gas in the current as 1 volume of gas to $10\frac{1}{2}$ volumes of mixture, the quantity of gas in 3,000 cubic feet, or the quantity of gas issuing from the mine per minute, is $\frac{3,000}{10.5} = 285.7$ cu. ft.

To render this mixture in explosive we must add sufficient air that the proportion will be 1 volume of gas to $13\frac{1}{2}$ volumes of air, or 1 volume of gas in $1 + 13\frac{1}{2} = 14\frac{1}{2}$ volumes of mixture (the lower explosive limit being 1 : 13). The quantity of the mixture will then be $285.7 \times 14\frac{1}{2} = 4,142$ cu. ft. The quantity of air to be added therefore to render the current in explosive is $4,142 - 3,000 = 1,142$ cu. ft. per min.

Ques. 5.—An entry 7 feet high and 8 feet wide is filled with gas 100 feet from the face, what would be the result if you entered this heading with an open light?

Ans.—This body of gas would form an exceedingly explosive mixture where it diffuses into the current circulating in the mine airways. The entry of a naked light into this mixture would result in a serious explosion.

Ques. 6.—State the names of all gases found in mines, and in what part of the mine you would expect to find the same, and under what conditions.

Ans.—This question is fully answered in reply to Ques. 22, page 378, MINES AND MINERALS, March, 1901.

Ques. 7.—State the different causes of mine explosions, and what means you would employ to prevent them?

Ans.—The cause of mine explosions is almost invariably the ignition of a body of firedamp in the workings or passageways of the mine. Ignition may take place by the contact, with a firedamp mixture, of a naked lamp, or the flame of a blast or blown-out shot, or the flame of a safety lamp blown through the gauze by too strong an air current. At times ignition takes place from the sparking of an electric current or motor. In a few instances mine explosions have occurred from the explosion of a quantity of blasting powder owing to the carelessness of the man handling the same. The initial explosion of this powder may stir up a large amount of fine coal dust, and this becoming ignited in the flame of the explosion will propagate or carry the flame to isolated bodies of firedamp and cause a mine explosion. To avoid the ignition of firedamp mixtures, the mining law with respect to the use of safety lamps should be strictly enforced in all of its details. The firing of shots should be placed in the hands of a duly authorized and experienced miner whose duty it would be to fire all shots in rotation, beginning upon the intake of the air, examining each working place in the vicinity of the blast before firing the same. Where the coal is brittle and of an inflammable nature it is important to avoid the accumulation of fine dust and slack at the working face. This should be loaded out regularly as it is formed. In mines where electricity is used, every precaution should be taken to avoid the ignition of gas by incandescence of the wires or sparking of the current. See answer to Ques. 17 above.

Ques. 8.—Name and describe the different instruments used to examine the condition of the atmosphere of a mine, showing the principle and application of each.

Ans.—The gaseous condition of the mine atmosphere is determined by means of the safety lamp. For this purpose a common Davy lamp is generally preferred. The Davy lamp and its principle are fully described in answer to Ques. 5, page 379, MINES AND MINERALS, March, 1901. The application of the safety lamp to determine the amount of gas present in the mine air has been described fully in answer to Ques. 3, page 427.

Atmospheric conditions are determined by the thermometer

and the barometer. The thermometer is the ordinary house thermometer, and is employed to ascertain the temperature of the air at the point where the velocity of the current is measured, since any change in the temperature of the air affects at once the volume or quantity of air in circulation. For this reason it is always important to note the temperature of the air in connection with anemometer readings in careful investigations. The mercurial barometer is the form of barometer usually employed in mining, and is stationed upon the surface near the mouth of the mine. At times the barometer is self-registering. The instrument consists of a glass tube about 3 feet in length closed at one end. The tube is filled with mercury from which the air has been expelled by boiling. When the tube is inverted and the open end submerged in a vessel containing mercury, the column of mercury sinks to such a level or height as will be supported by the atmospheric pressure. At sea level, the height of the mercury column is 30 inches, under normal atmospheric conditions. At elevations above the sea level, the reading of the barometer is less; and at elevations below the sea level, this reading is greater, the difference in barometric height being about 1 inch for every 90 feet rise or fall from sea level. The principle of the barometer may be stated as follows: the weight of the atmosphere pressing upon the surface of the mercury in the vessel balances the weight of the mercury in the tube, there being a vacuum (no pressure) above the mercury column, the calculated weight of this column for any given area of cross-section shows exactly the atmospheric pressure upon the same area. (See answer to Ques. 20, page 427, also Coal and Metal Miners' Pocketbook, 6th edition, page 339.) The aneroid barometer is sometimes used instead of the mercurial barometer, since it is more portable. This form of barometer consists of a brass vacuum box from which the air has been exhausted. One side of the box is corrugated and is sensitive to the least variation in the pressure of the atmosphere upon it. The movement of the side of the box as caused by the variation of the atmospheric pressure, is communicated by a set of levers and gearing to a pointer upon the dial or face of the instrument. The readings of the aneroid barometer are made to correspond to those of the mercurial barometer. The application of the barometer to mining is found in the fact that any change in the atmospheric pressure affects sooner or later the volume of the gases contained in the abandoned workings of the mine. A fall of the barometer shows a decrease of atmospheric pressure which results in an expansion of the volume of gases in the mine workings. A large amount of gas is thus thrown out upon the airways which often results in causing a dangerous condition of the air current.

The conditions relative to the circulation of the air current in the mine are determined by the use of the anemometer and water gauge. The anemometer is an instrument consisting of a small vane revolving in a circular frame. The revolutions of the vane are recorded by means of several pointers upon the face of the instrument. There is usually one large pointer that makes one revolution for each hundred revolutions of the vane. The dial for this pointer has one hundred divisions, each division indicating 1 foot of velocity in the air current. The smaller dials are arranged decimally by a system of gear wheels to register 1,000, 10,000, etc. feet, for each revolution of their respective pointers. The principle of the anemometer depends upon the inclination of the blades being such that 1 foot of lineal velocity in the passing air current produces one revolution of the vane. The use of the anemometer is for determining the volume of air passing per minute in the airway.

The water gauge has been fully described in answer to Ques. 13, page 232, MINES AND MINERALS, December, 1900.

Ques. 9.—When are gobs most dangerous?

Ans.—The gobs (goaves) of the mine become most dangerous when they are not thoroughly ventilated, thus furnishing a lurking place for the accumulation of standing bodies of gas. The goaves are also dangerous when on account of the storage of the fine coal and slack in the waste, gob fires are a frequent occurrence. Some coals have a greater tendency to heat and fire when stored in the gob than others. Gobs may also be considered as a dangerous element when they are full of standing timber and the entry is strong. An undue pressure is thereby thrown upon the entry pillars and stumps, which may induce creep. All standing timber should be removed from abandoned workings so as to induce a fall of roof.

Ques. 10.—What is a safety lamp?

Ans.—A safety lamp is a lamp so constructed that it will burn in a gaseous atmosphere, without igniting the gas outside of the lamp. See also answer in reply to Ques. 8, above.

Ques. 11.—Would you consider it safe to work with open lights in any portion of a mine generating explosive gas? Explain why.

Ans.—Mines generating explosive gas are not always dangerous in every portion of the workings. Some mines generate explo-

sive gas in dangerous quantities only in certain sections; for this reason open lights are permitted to be used in many mines generating explosive gas. There is usually a lamp station located at some point within the workings beyond which it is prohibited to use anything but locked safety lamps. The conditions that would permit of the use of open lights in workings generating gas occur only where the ventilation of the workings is ample and reliable. Even then it cannot be said that the use of open lights is unattended with danger, since at any time a heavy feeder of gas may be opened by a blast or fall of roof, which would render the workings in the vicinity extremely dangerous. Where open lights are used under these conditions it is not always possible to give the warning quick enough to those using open lights to avoid an explosion. For this reason, if absolute safety is to be secured, open lights should always be prohibited in the workings of a mine generating gas, but on account of the annoyance and hindrance to the workmen in such mine the use of open lights is permitted. The men themselves prefer to run the risk of explosion rather than to be compelled to work with locked safety lamps under these conditions.

Ques. 12.—If there are three sections ventilated by one current; and upon visiting the mine you found a blue flame on the safety lamps in the middle section, what would you do for the safety of the miners in the other sections, and state whether you can tell beforehand which of the sections would require the most immediate attention?

Ans.—The discovering of a blue flame in the lamps of the middle one of three sections ventilated by the same current of air would indicate the probable generation of gas in this section. The men in the middle section should be ordered to withdraw at once until an examination could be made as to the quantity of the gas and its source. The men in the section immediately adjoining the middle section on the return side should likewise be withdrawn at once. After the withdrawal of the men from these two sections, the fire boss should first proceed to examine carefully the section upon the other side where the men are still working, and to ascertain to a certainty whether there is any gas in that section. If there is no gas found in the section upon the intake side, the fire boss should next give his attention to the examination of the middle section, following the current in its course through these workings. If anything can be done to increase the volume of air passing in these sections it should be done at once, and every precaution taken to prevent explosive conditions of the air current. In no case should men be allowed to remain in the middle section or in the section upon the return side of this, until a safe condition of the air is secured.

Ques. 13.—In a mine generating explosive gas what precautions should be used when blasting has to be done, to insure the greatest possible safety?

Ans.—This question is fully answered in reply to Ques. 21 above.

Ques. 14.—A bore hole from the surface is 6 inches in diameter and enters the rib fall in the mine; a mixture of 50 per cent. of CH_4 and 50 per cent. of air is passing up the hole with a velocity of 130 feet per minute, what is the volume in cubic feet, and what would be the volume if sufficient air were added to bring the mixture up to the highest explosive point?

Ans.—The volume of air discharged from this bore hole per minute would be $.7854 \times .5^2 \times 130 = 25.52$ cu. ft. Since this volume contains 50 per cent. of marsh gas (CH_4) the volume of gas discharged per minute is $25.52 \times .50 = 12.76$ cu. ft. The fire-damp mixture at its most explosive point contains 9.38 per cent. of gas (see answer to Ques. 4, next above). Hence, the volume of the gaseous mixture after adding sufficient air to bring it up to its most explosive point would be $\frac{12.76}{.0938} = 136+$ cu. ft. per min.

Ques. 15.—What is the most difficult gas to contend with in mining? Explain.

Ans.—The difficulty encountered in contending with a large body of any particular gas depends primarily upon the conditions of the workings with respect to the inclination or dip of the seam. The lighter gases, as marsh gas (CH_4), and carbonic oxide gas (CO), are more easily handled in the ventilation of dip workings, while the heavier gases as carbonic acid gas (CO_2) and sulphuretted hydrogen gas (H_2S) are more readily handled in rise workings. This is due to the specific gravities of these gases. The lighter gases having a lower specific gravity tend to rise to the higher portions of the mine, while the heavier gases owing to their greater specific gravity tend to fall to the lower portions of the mine where they accumulate until removed by the current. Therefore, if the lighter gases are generated in the lower workings, or if the heavier gases are generated in the upper workings of a mine, the ventilation will be accomplished much more readily than if the reverse of this is true.

The manner of occurrence of the gas will also increase or decrease the difficulty of contending with the same. Gas feeders

(CH_4 or H_2S) occurring in the floor of the workings are often troublesome from their becoming ignited by the flame of a blast and drawing back under the gob or waste where it is difficult to extinguish them. If not extinguished, these gases become a menace to the safety of the mine, inasmuch as they are liable to cause a mine fire of considerable proportions in the gob. Such gas feeders should be followed up and extinguished if it is possible to do so. A means often employed for this purpose is the exploding of a small amount of dynamite in the workings in close proximity to the burning feeders. The concussion of the explosion will generally extinguish the burning gas. Gas feeders occurring in the roof of mine workings are often difficult and dangerous to contend with owing to their accumulating above the roof slate, and causing the same to settle away from the strata. Bodies of gas accumulated above the roof slate in this manner are a dangerous element in the workings. See article, Dangerous Roof or Top in Coal Mining, page 381, MINES AND MINERALS, March, 1901.

Ques. 16.—If you were acting as fire boss, and had a heading driven 200 feet ahead of the last cut-through being made, and you found in your examination that the heading contained explosive gas back 100 feet from the face, how would you proceed?

Ans.—The fire boss in this instance has gone contrary to the mine law with respect to driving an entry too far in advance of the air. See last clause of Art. 6, Sec. 3. The section reads:

It shall be the duty of the mine foreman to see that proper cut-throughs are made in all the room pillars at such distances apart as in the judgment of the mine inspector may be deemed requisite not more than thirty-five nor less than sixteen yards each, for the purpose of ventilation and the ventilation shall be conducted through said cut-throughs into the rooms by means of check doors made of canvas or other suitable material placed on the entries or in other suitable places and he shall not permit any room to be opened in advance of the ventilating current. Should the mine inspector discover any room, entry, airway or other working places being driven in advance of the air current contrary to the requirements of this section he shall order the workmen working in such places to cease work at once until the law is complied with.

The first thing to be done under the circumstances would be to withdraw the men from the return of the current passing in this heading. The fire boss should then, with the assistance of experienced men, erect a temporary brattice starting from the outbye rib a (Fig. 3) of the last cut-through, by setting posts from this rib forward toward the face of the entry in a line about 2 feet from the rib, as shown in the figure. Canvas or brattice cloth is then nailed to the posts forming a brattice around which the air current is forced to circulate. The men must work on the outbye side of the brattice when they have reached the point where the gas is located. The circulation should be increased, if necessary, as much as possible, and the work should be carried

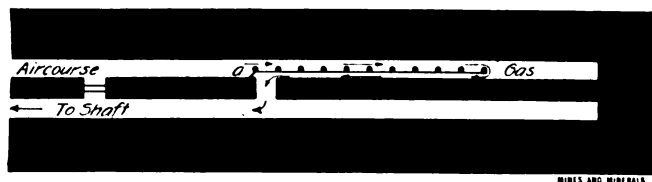


FIG. 3.

forward with great caution, constant attention being paid to the lamps, which should be carefully examined before approaching the gas, and at intervals during the progress of the work, to see that the gauzes are clean and that the lamps are in good working condition. The lamps should not be taken forward into the body of the gas, but should be placed in a safe position back of the workmen and where they will be protected from the gas. The work should not be carried forward too rapidly, but time should be allowed for the gas to drain off after setting each post and extending the brattice. The work should be carried forward in this manner to the face of the entry. As soon as the body of gas has been removed, a breakthrough should be cut in the pillar at a point not more than 35 yards from the last breakthrough, to comply with the mine law as stated above. Another breakthrough should then be cut in the pillar at a point, say 20 yards inside of this last one. The brattice can then be taken down after closing the two outside cut-throughs. If the gas is issuing in such quantities at the face of the heading as to require better ventilation than is afforded by this last cut-through, the brattice used previously should be extended from the outbye rib of the last breakthrough, toward the face of the entry, and maintained as close to the face of the heading as possible or necessary.

Ques. 17.—What should be the nature of your daily mine report as mine foreman and as fire boss, as required by the mine law?

Ans.—After each examination of the mine by the fire boss he is required by law (Art. 6, Sec. 8) to enter in a book provided by the mine inspector for that purpose, a record of the examination

he has made. The record shall clearly state the nature and location of any danger which he may have discovered. As mine foreman, he must enter in said book a record giving the condition of the mine and stating clearly any danger that may have come under his observation during the day. This entry shall also state whether he has, as a mine foreman, a proper supply of material on hand for the safe working of the mine, and also whether all the requirements of the law are being strictly complied with. Each week the mine foreman is obliged to enter plainly, with ink, in said book, a true record of all air measurements required by law.

PECULIAR GEOLOGICAL FORMATIONS

Of the Southern States—Circumstances Which Cause Them, And Their Relation to Vein Formation and Mining.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

A traveller through the Southern States, from Memphis, Tennessee through Alabama, and North and South Carolina, cannot fail to be struck with the gay red and yellow colors of the soil pervading the entire region, as shown by the road side and in railway cuttings. Occasionally in an unusually deep cutting he may trace this red soil lying upon and passing down into underlying schists or slates standing on edge at a very steep angle, or absolutely vertical. In these schists or slates he may observe narrow lenses and lenticular veins of white quartz seemingly parallel with the bedding of the schists, but in reality cutting them at a very acute angle, and sometimes cutting plainly diagonally across them, showing clearly that the veins in either case occupy true fissures in the slates, and that the veins are "true fissure veins" although lenticular, or formed of a succession of lenses interbedded with the schists; further, that they occupy fissures formed later than the forces that produced the schistosity of the rocks.

Occasionally, though more rarely, instead of a zone of these narrow veinlets we have broad strong veins of usually barren, but at times auriferous white saccharine, or vitreous, quartz, traversing the country for miles and from ten to 20 ft. or more thick. In some localities he may see and trace for miles across country dark diabase dikes from 20 to even 500 ft. thick. These dikes have, in many cases, favorably influenced the deposition of ore, as at the Haile, Brewer, and other mines, the slates and veinlets in their vicinity being charged with free gold and pyrites and the slates generally hardened and silicified near the contact. Dikes of diorite and other igneous rocks and porphyries occur, and locally there are patches of granite breaking through the schists and slates. The origin of the slates and schists may be in part sedimentary and metamorphic, but for the most part the schistose condition is the result of dynamic shearage movements. The greenish schists are in many cases sheared representatives of former diorite and diabase dikes. All these rocks are near the surface in a state of more or less thorough decomposition.

Besides the red soil another striking feature is the extraordinary quantity of white quartz fragments scattered far and wide over the fields. Some of these fields are a literal Arabia Petrosæ, or like a sea beach, so thickly are the fragments scattered. The cotton plants grow between the quartz fragments, no effort being made to cart the rock away.

Amongst these quartz-covered fields we may look almost in vain for any trace or fragment of country rock, such as schist or slate, that may once have enclosed the quartz. One might conceive that a huge quartz meteor had burst in the air and scattered the whole country, far and wide, with its fragments.

There is no evidence of soil or drift material accumulated, or transported by glaciers, the great ice sheet, or the broad rivers and lakes of the Quaternary epoch, such as we are accustomed to in more Northerly mining regions. It is clear that the great agencies of the glacial epoch never held sway over this area, and that it is a region which has not suffered severely from any of the great eroding agencies, consequently so to speak, everything is "in place," occupying the area it did from a primeval age.

The red and yellow soil has never been transported but is the result of slow secular decomposition of the underlying rock, be it granite, slate, schist or diabase, forming what Mr. Geo. F. Becker has termed saprolites or rotten rocks.

The quartz fragments are the ruins and remains of countless veins and veinlets, such as we have described as seen now embedded in the schists. These doubtless were once embedded in the schists when the country stood a good deal higher than it does now. From these quartz veins and lenses the soft country rock enclosing them gradually decayed dropping the fragments with great slowness and infinite gentleness in the same area where they once existed as forming vertical and perhaps prominently outcropping veins. We observed a striking instance of this letting down of veins in a property located on a hill in South

Carolina. On this hill were the bold outcrops of a number of quartz veins which, on the surface we assumed to be from 10 to 50 ft. wide, judging from the seeming thickness of the castellated or massive fragments of quartz.

We had occasion to test one of these veins by a shaft and cross cut at a depth of 75 feet and, to our surprise, the vein which at the surface we assumed to be 15 to 20 ft. thick or more was found at this depth to be only 6 to 8 ft. wide.

The cause of this illusion was that the surface outcrop of massive fractured quartz represented the ruins of the ancient vein which, as the soft saprolitic country rock decayed from it, gradually sat down, so to speak, in a ruined state like the ruined column of some ancient temple lying upon its own base or site.

Another cause of the seeming wide appearance of the outcrops of these veins was that the veins had a low dip of 30 to 40 degrees, which was cut diagonally rather than at right angles by the sloping surface of the hill, showing a wide transverse section rather than a section at right angles to the dip.

From a mining point of view these wide surface outcrops extending it may be, for a mile or more in length across country, being oxidized to a depth of 20 to 50 ft. and carrying free gold, offer an immense amount of free milling material that could easily be quarried out in open cuts.

Many mines are opened in this way, and in the region of saprolitic slates and schist carrying wide zones of narrow lenses and veinlets of quartz and country rock impregnated with free gold and sulphides, enormous craterlike pits are opened 200 ft. wide and 75 to 100 ft. deep, as at the Haile and Brewer mines in South Carolina, described in MINES AND MINERALS for Sept., 1900.

We are told in geology that all soils were originally red, till leached of their iron by organic and other agencies. So here we appear to have the primitive soil in place; doubtless the same conditions existed in the Northern States before the glacial epoch, but the descending, moving ice sheet swept off all this soft red saprolitic material and transported it elsewhere to form alluvial soils and the vein matter to form gold placers, laying bare the underlying rocks and veins until they were, in turn, covered by transplanted material.

Hence, in the North we have bared rocks and bold outcropping veins and large alluvial and placer deposits of transported material, strikingly different from that existing in the South. Hence, also, both prospecting and mining are carried on under very different conditions. Speaking of the saprolitic and other gold bearing formations in the Southern States Mr. Becker says: "Gold occurs in true stream gravels and auriferous accumulations of rotten rock in place."

"Decomposition in the unglaciated South extends to 50 to 100 ft. in depth. Where the mass was originally intersected by gold quartz seams and impregnations of the wall rock, the decay to soft earth takes place without sensible loss of the precious metal. Such deposits can be worked with pick and shovel, or by hydraulicking. In such deposits the original structure of the rock is perceptible to within a couple of feet of the surface. The material is substantially "in place." Such rock is found universally in unglaciated regions even within the Arctic Circle."

"In the Dahlonega district a system adopted is, to hydraulic the saprolites, the fine earth escaping after passing through sluices, while the fragments of vein quartz are thrown out by grizzlies and passed through the stamp mills. The losses in this process are great owing to, it would seem, the enclosure of gold particles by films of iron oxide, or other substances, preventing amalgamation. Geologically the saprolites are identical with the more solid masses beneath them, but in some saprolites an endless number of the thinnest possible quartz veins and lenses are accessible; not merely in section but in three dimensions. You can pick out of the saprolites pieces of vein several square inches in area scarcely thicker than writing paper."

"The gold found in saprolites is rough and masses of wire gold occur. By thawing, freezing and effects of sunshine expansion and contraction, the material flows down and is fed into the headwaters of streams. Much gold has been obtained from modern rivulets, or branch gravels. Saprolites favor the concentration of many gems and other rare minerals found in the washings. As regards the veins, these are found in true fissures intersecting the schists. Their persistency with depth need cause no uneasiness. The veins date from a pre-Cambrian period and the present croppings are far below the original ones."

"If mining could be carried on to an unlimited depth the fissures would grow smaller, for the greater the pressure of the superincumbent mass, the greater must have been the tendency to close openings formed under catastrophic conditions, but the total depth of fissures measured from the original surface is most likely of the same order as, and in proportion to, their length, which is, in many cases, several miles, while no mine has ever reached a depth of one mile. As veins may branch in a vertical as well as a horizontal direction cross-cutting is essential."

NEW INVENTIONS.

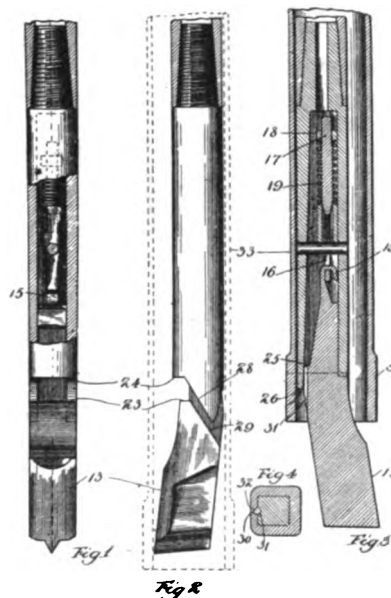
EDITED BY H. M. LANE, M. E.

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ROCK DRILL.

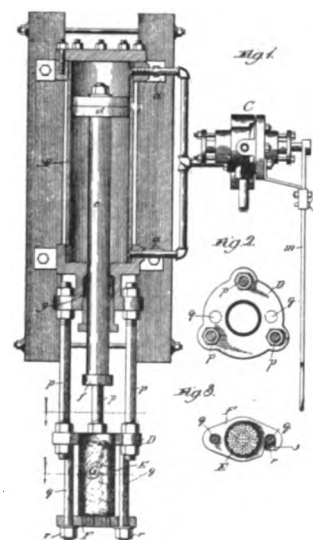
No. 685,711. O. G. WOBSLEY, NEWARK, ILL. *Patented January 8, 1901.* This patent relates to a special form of rock drill intended for undercutting a casing pipe.



partly in the bit and partly in the bit stock is provided for the flow of water. This is shown at 31 and 32, Figs. 3 and 4.

AMALGAM PRESS.

No. 664,330. A. MACKAY, DOUGLAS ISLAND, ALASKA. *Patented December 18, 1900.* This device is intended for expressing the surplus quicksilver from amalgam and consists of a cylinder A mounted upon any suitable framework and connected by means of pipes a with a 4-way valve C by means of which a fluid (air, steam or water under pressure) may be introduced into one end while the other end is connected with the atmosphere.



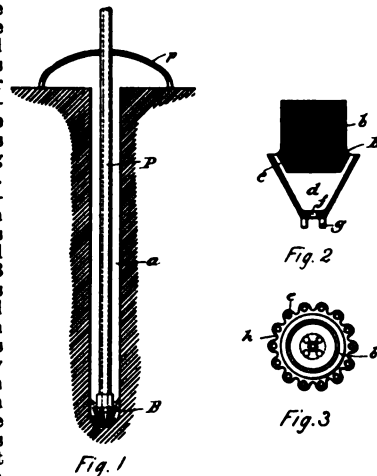
a position as to admit fluid above the piston D and force the head F of the piston rod into the cylinder G. This head is made a good free fit in the cylinder so that it will compress the amalgam and force the surplus mercury out through the openings in the cylinder E and the plate F. After this the lever m is so moved as to relieve the pressure upon the piston, the plate F loosened and swung to one side and pressure

once more brought upon the piston and the bag of pressed amalgam forced out of the cylinder E.

FORCE JET DEVICE FOR CLEANING QUARRY HOLES.

No. 668,799. S. W. & H. F. BUCKWALDER, READING, PA. *Patented Feb. 29, 1901.* This patent covers a device shown in the accompanying figures and is intended for cleaning drill holes for quarry or mining work.

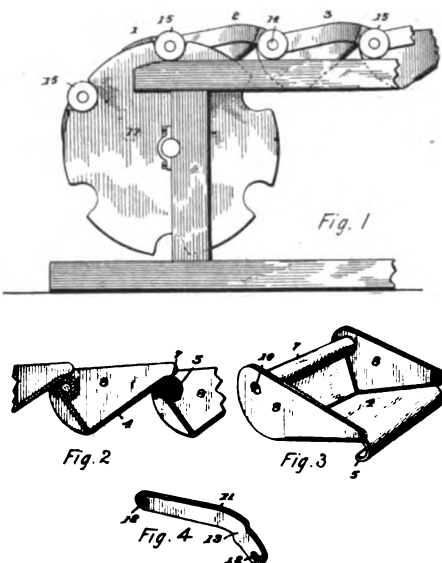
a represents a hole which has been drilled, into which the pipe P is introduced. At the end of the pipe there is a head B which is constructed as shown in Fig. 2. The upper portion b of the head is threaded to screw onto the pipe. The lower end is provided with lugs or legs g to keep the opening f off the bottom of the hole. The lower end of the head contains the chamber d from which the opening f communicates downward and the inclined openings e upward. Fig. 3 shows a plan of the device as is seen from above, and it will be noticed that between each pair of the openings e there is a groove h through which any dirt in the hole can be blown up by means of a jet through the hole f. In operation the device is placed in the hole as shown in Fig. 1, and a current of compressed air or steam turned in through the pipe P. The jet passing out through the hole f cleans the bottom of the hole, while the jets passing out through the holes e raise the material toward the surface. The pipe P is then withdrawn from the hole while the pressure is on, so driving everything out and cleaning the sides thoroughly. In order to prevent the material from being thrown around too extensively and to protect the operator from the dust or steam, the shield p may be used over the hole around the pipe P. The inventor claims that by this device a hole can be cleaned, dried, and made ready for charging the powder very quickly.



ORE CONVEYER.

No. 667,192. W. R. CRAIG, SHELBY, ALABAMA. *Patented Feb. 5, 1901.* This patent covers a special form of conveyer bucket, as illustrated in the accompanying figures.

Fig. 1 represents a portion of the conveyer in place, 17 being the driving wheel at the end, 1, 2, and 3 buckets in place, 15 rollers or wheels which carry the buckets, 14 the shaft which connects the rollers 15 and joins the buckets. The construction of the bucket may be seen by reference to Fig. 3. It may be composed of a single sheet of metal 4, the front end of which is bent down to form the lip 5 and the back end of which is turned around to form the tube 7, as seen in Figs. 2 and 3. The sides of the buckets may be made by bending up pieces as shown at 8, or they may be riveted on separately. The sides are provided with holes 10 which register with the opening through the tube 7. The buckets are coupled up, as shown in Fig. 2, by hooking the lip 5 over the tube 7. In order to strengthen the system, rods or straps, as shown in Fig. 4, may be placed on the sides of the buckets. These are provided with holes 12 which register with the holes 10 of consecutive buckets. The rod or strap 11 is also provided with an offset 13 so that the front end of any given strap may come outside the back end of the one in advance of it. The claims are for great simplicity and strength in the bucket.



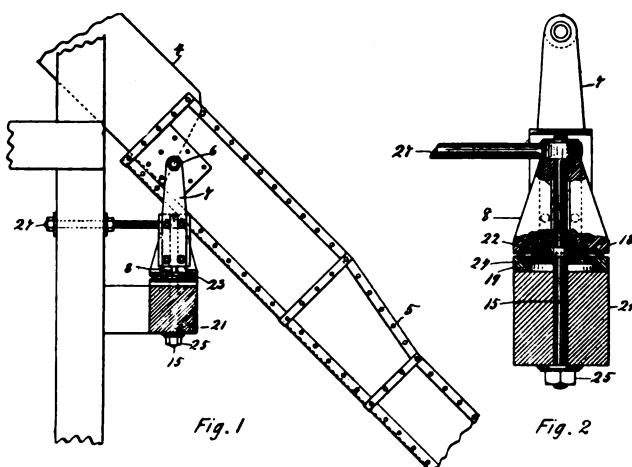
PROCESS FOR TREATING SULPHIDE ORES.

No. 665,744. H. F. KIRKPATRICK-PICARD, LONDON, ENG. *Patented January 8, 1901.* This process is intended for the treatment of complex sulphide ores, especially those containing zinc, lead, gold, silver and sulphur. The ore is first ground to a fine powder and submitted to an oxidizing roast in the reverberatory furnace in order to procure the maximum amount of the oxides of lead and zinc and the minimum amount of sulphates. In order to produce the maximum amount of oxides the inventor finds it necessary to add a small amount of coal

slack or other carbonaceous material with the roasted charge while still in the furnace and to reheat the mixture for the further decomposition of sulphates. By these means he claims that the amount of lead sulphate left in the charge may be reduced so low that it is of no importance. After the rest of the ore is removed from the furnace it is mixed with coal or a mixture which on carbonization will produce a coke. This mixture is then briquetted and submitted to a zinc distilling heat in a retort or muffle furnace. The zinc is reduced to a metallic state, but are left behind in the retort suspended or hung up in a carbonaceous sponge or skeleton. This prevents the rapid corrosion of the retorts by the metallic lead. The lead, gold, silver, etc., may be subsequently recovered by smelting and the author claims that the presence of a small amount of zinc in the base bullion is advantageous in that it lessens the amount that must be added to desilverize the lead.

ADJUSTABLE COAL OR ORE SPOUT.

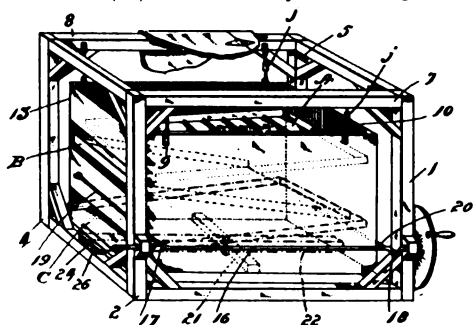
No. 667,335. J. L. REORD, MINNEAPOLIS, MINN. *Patented Feb. 5, 1901.* This invention covers a device by means of which a chute from a coal or ore pocket may be mounted in such a manner that it can swing in



the arc of a circle so as to be able to discharge the contents of the bin over a wider range than in the case of stationary chutes. The short fixed chute 4 is connected to the bin and discharged into the movable chute 5 which is mounted upon pivots 6 at the top of a pair of standards 7. These pivots 6 allow the chute 5 to be raised or lowered. The standards 7 are carried upon a bolster body 8 which is mounted upon a plate 19 secured to the timber 21 of the bin frame. Between the plate 19 and the bottom of the bolster there is introduced a series of balls 13 and the entire structure is kept in a proper position by means of the through bolt 15 and the projections 22 and 24 which are arranged to fit one another. The upper end of the bolt 15 is secured to the dock by means of the I bolt 27 and the lower end is secured by the nut and washer 25. The upper end of the chute 5 is made wider than the chute 4 so as to allow the frame to swing through quite an arc without breaking connection with the chute 4.

ORE CONCENTRATOR AND SEPARATOR.

No. 667,514. G. J. FREY, OAKLAND, CAL. *Patented Feb. 5, 1901.* The device covered by this patent is illustrated in the accompanying figure, and is intended for separating gold from other material, as for instance from placer sand. The device consists of a substantial frame composed of posts 1, 2, 4, and 5, and horizontal pieces, as 7-8, etc. Suspended from the horizontal rails 7-8, by means of rods and adjustable couplings 9 and 10, there is a box 13 which carries a series of pans A. These are made of metal and provided with riffles m, m' and m''. The pans are placed one above the other and slant in opposite directions, as shown at A, B, and C. Each pan is arranged to discharge into the one below it. The frame or box 13 has a bar 21 secured to its under side and the supporting framework has a bar 22 running longitudinally under the entire frame. These two bars are connected by a bolt which forms a pivot on which the box 13 may be rotated through a small angle. In order to rotate the box it is connected to a shaft 16 by means of connecting rods 19 and 20. These connecting rods are attached to cranks 17 and 18, which are arranged with the throw opposite so that as one end of the box advances toward the shaft the other one recedes from it. The shaft may be driven by any suitable means and will give the box and its contained pans an oscillating motion. Under the box are arranged a series of metal strips at 24 which engage another series



of metal strips at 26, the latter being secured to the framework. By adjusting the turnbuckles J the box may be arranged so that the metal strips engage one another, thus giving the entire framework and pans a jolting motion. The material to be separated is charged onto the upper pan A by any suitable means and water added to wash it down over the riffles. The gold is collected behind the riffles, either on account of its specific gravity or by coming in contact with quicksilver.

METHOD OF TREATING THE CONVERTER SLAG PRODUCED IN BESSEMERIZED COPPER MATTES.

No. 667,387. G. MITCHELL, JEROME, ARIZ. *Patented Feb. 5, 1901.* The process covered by this invention is intended to provide a means for settling the matte-prills contained in the slag without the necessity of resmelting the converter slag. It consists in using a very large forehearth before the blast furnace, into which both the matte and the slag from the furnace flow. The slag from the converter is brought to this forehearth and poured in near the point where the products of the furnace are introduced. The matte and slag from the furnace, being very hot, raise the temperature of the converter slag, thus making it more fluid and aiding the separation of the matte from the converter slag. The matte is tapped from the forehearth in the usual manner and the separated slag allowed to overflow as usual.

PATENTS ISSUED DURING FEBRUARY AND NOT ILLUSTRATED.

- No. 667,187. Machine for sharpening or shaping drills, A. Carstens, Leadville, Colo.
- No. 667,201. Flight conveyer, T. A. Edison, Llewellyn Park, N. J.
- No. 667,254. Briquet machine, R. Schorr, San Francisco, Cal.
- No. 667,255. Process of producing lime or cement and fixed combustible gases, A. L. Schubert and F. J. Pierce, Sacramento, Cal.
- Nos. 667,313; 667,314; 667,315. Excavator, O. Hetlesater, Chicago, Ill.
- No. 667,440. Conveying appliance, W. S. Halsey, Pittsburg, Pa.
- No. 667,476. Hoisting bucket, A. Wirsing, Milwaukee, Wis.
- No. 667,664. Rock-drilling machinery, R. L. Ambrose, Tarrytown, N. Y.
- No. 667,777. Crushing rolls, F. M. Her, Denver, Colo.
- No. 667,780. Safety cage chair, No. 667,781. Cage-chair operating mechanism, M. W. Jelinek, Black Hawk, Colo.
- No. 667,823. Rear jack for coal-cutting machines, D. W. Jones, Rawndale, O.
- No. 667,975. Elevating and conveying apparatus, J. M. Dodge, Philadelphia, Pa.
- No. 668,050. Conveyer, S. B. Peck, Chicago, Ill.
- No. 668,079. Conveyer, H. W. Baker, Chicago, Ill.
- No. 668,112. Stone-boring machine, S. Messropian, Toulon, France.
- No. 668,209. Deep-well drilling apparatus, C. D. Pierce, Jersey City, N. J.
- No. 668,234. Apparatus for use in the manufacture of coke, M. M. Suppes, Elyria, O.
- No. 668,238. Hydraulic elevator, J. E. Wait, Detroit, Mich.
- No. 668,266. Process of producing concentrates containing high percentages of titanic oxide, A. J. Rossi, New York, N. Y.
- No. 668,282. Amalgamator, No. 668,283. Amalgamation of Ores, C. G. Collins, Woodmere, N. Y.
- No. 668,342. Hydraulic dredging appliance, E. Risley, Pleasantville, N. J.
- No. 668,371. Gold-washing machine, L. Franklin and J. Tonnar, Anaconda, Mont.
- No. 668,378. Conveyer, M. Korth and W. Garrity, Franklin Furnace, N. J.
- No. 668,402. Coking furnace, P. B. Elkins, Pittsburg, Pa.
- No. 668,464. Crosshead for mine shafts, J. T. Semmens, Bald Mountain, Colo.
- No. 668,488. Amalgam squeezing machine, J. V. Coleman, San Francisco, Cal.
- No. 668,493. Tripod for rock drills, J. J. Crippen, Denver, Colo.
- No. 668,578. Stamp mill, G. L. Gibson, Denver, Colo.
- No. 668,585. Brick from iron ore and process of making same, A. Ronay, Puda-Pesth, Austria-Hungary.
- No. 668,593. Mining drill for coal or rock, A. Walker, What Cheer, Iowa.
- No. 668,600. Mine-door operating and signal system, J. Burns, Kenesee, Ky.
- No. 668,643. Amalgamator, T. H. Hicks, Fort Wayne, Ind.
- No. 668,651. Crusher, W. H. Lingo, Hollyville, Del.
- No. 668,742. Ore separator, W. A. Redding, Macon, Ga.
- No. 668,803. Crucible and crucible furnace, A. Reynolds, Sheffield, Eng.
- No. 668,828. Rope socket for well drilling tools, G. F. Bell, Sistersville, W. Va.
- No. 668,842. Apparatus for electrolytically extracting and depositing gold and silver from their ores, A. M. Rouse, Denver, Colo.
- No. 668,852. Ore concentrating apparatus, A. A. Francis, Bergamo, Italy.
- No. 668,940. Electromagnetic separator, No. 668,941. Method of magnetically separating ores, G. H. Waring, Tyrone, Pa.
- No. 668,952. Desulphurizing copper matte, G. C. Carson, Castella, Cal.
- No. 668,980. Ore Concentrator, C. A. Christensen, Oretown, Ore.
- No. 669,007. Process of manufacturing zinc amalgam plates, G. T. Eyanon and A. J. Shinn, Philadelphia, Pa.
- No. 669,019. Process of treating furnace slag, S. W. Vaughen, Johnstown, Pa.
- No. 669,058. Electric Amalgamator, L. N. Barricks, San Francisco, Cal.
- No. 669,038. Concentrator, S. W. Traylor, Denver, Colo.
- No. 669,043. Concentrating apparatus, A. K. Cross, Denver, Colo.

Mines ^{and} Minerals

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GOLD MINING IN ALASKA.

A Description of the Southeastern Part of the Country, Its Formations and Some of the Mines.

Written for MINES AND MINERALS, by Prof. H. van F. Furman.

During the summer of 1900 the writer had occasion to examine a number of the gold mines of the district of Southeastern Alaska, and as the trip proved both interesting and instructive, a brief description of the country and its mines may be of interest to the readers of MINES AND MINERALS.

Leaving the city of Seattle at midnight, on the steamship Cottage City, we arrived at the sleepy town of Victoria, British

fur trading post. Two or three years ago there was a considerable gold excitement here, and prospecting was carried on in the vicinity of Fort Wrangell and in the Cassiar district to the north; but the deposits appear to have been low grade and very little prospecting is going on at present. The Indian portion of the town is of considerable interest to tourists on account of the number of Totem Poles in front of their houses, many of them apparently quite old. We were obliged to remain at Wrangell several hours waiting for a favorable tide to take us through the narrow and shallow Wrangell Narrows, which are very difficult of navigation. Our next stop was at Juneau, where our party left the steamer.

Juneau is quite a substantial and a thoroughly American town. There are an excellent hotel, two banks, and a number of



FIG. 1. VIEW OF JUNEAU.

Columbia, early the next morning. This being the capital of British Columbia, the houses of Parliament and the various government offices are located here. The city is most picturesquely situated on Vancouver Island, and is the rival of Vancouver (located across the Straits of Georgia on the main land), although the latter city appears to have gained the commercial supremacy.

The next landing place was Ketchikan in United States territory. This town has been built up principally in the past year by parties prospecting for copper on Prince of Wales Island, which is situated to the west. Here the writer saw some fine specimens of copper ore, but did not inspect any of the properties, which have not as yet advanced beyond the prospect stage. After a stop of about an hour the boat proceeded on her journey, the next stopping place being Fort Wrangell, which was formerly an important

large and substantial commercial houses here. The United States Court, Marshal's Office, and a number of the other government offices of the District of Alaska have recently been transferred from Sitka to Juneau.

From Juneau the steamship Cottage City, which makes the voyage throughout the year, proceeds to Skagway and from that point to Sitka. During the summer season she stops at a number of salmon-canning and fish-oil establishments before returning to Juneau, and during the tourist season usually puts into the Muir Glacier, on her way between Skagway and Sitka. In December, 1899, Southeastern Alaska was subjected to a severe earthquake, which so fractured and broke up the face of the Muir Glacier that no boat has since been able to penetrate into Glacier Bay. At present the entrance to the bay is blocked by icebergs,

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many of them grounded on the bar, and even the passage of Icy Strait is rendered dangerous by the large quantity of floating ice and bergs which are encountered. This ice, except what is grounded on the bar, is carried back and forth by the daily tides, and it may be some years before the entrance to the bay is sufficiently free from ice to allow the passage of the large excursion steamers, and the steamship officials fear that the glacier is ruined as a show place for tourists. However, this is hardly probable, as the glacier has a flow of about 8 feet per day and it should not require nature long to repair the damage which the earthquake has done to the face of the glacier. During the summer season from 1,000 to 2,000 tourists now annually make the round trip from Seattle, which takes from 10 to 14 days, the time required depending upon the steamer taken. On the large steamers the accommodations and fare are good, and the trip may be made a most delightful summer outing. The route is by the inland passage, and during the summer months the only places where anything like an ocean swell, or rough sea, is liable to be encountered are in the passage of Queen Charlotte Sound (time about 4 hours), and in the passage of Dixon Entrance (time about 2½ hours). During the winter months severe gales and snow storms prevail and the voyage is not altogether pleasant, nor free from danger. The scenery during the entire trip is sublime, in fact the writer has encountered nothing in Switzerland or elsewhere which will compare with it in grandeur. Most tourists make the round trip on the same boat, only going ashore, for at most a few hours, at such points as the boat may make a landing. A great deal of

the surface is covered with moss, fallen timber, and an undergrowth which is almost tropical in its abundance. This is partly illustrated in Fig. 3, which shows a prospector's cabin in the Berners Bay district. Above timber line the mountains are either precipitous or are covered with snow and ice, glaciers, both active and dead, being quite commonly encountered. Below timber line the underlying rock is seldom exposed to view except in the beds of the present watercourses. These conditions render prospecting extremely difficult, in fact the country has only been roughly prospected along the shore, and occasionally inland for distances seldom exceeding two or three miles. Owing to the heavy rain and snow fall, I should judge the annual precipitation to exceed 100 inches, and the perpetual snow banks and glaciers on the mountain summits, rivers, streams, and waterfalls are encountered almost everywhere. This is of great economic importance, as the exploration, exploitation, and treatment of the low-grade gold ores of the district are largely dependent upon obtaining cheap and convenient water power.

Transportation and Supplies.—As transportation to all of the coast towns is by water, supplies at these points are abundant and comparatively cheap. In fact the cost of living and supplies at points adjacent to tide water are not generally greater than in the majority of mining camps of the Rocky Mountain region. Laborers receive \$2 per day and board, miners \$2.50 per day and board, whilst experienced mill men receive from \$4 to \$5 per day and board. As, practically, the only means of transportation is by water, a prospector in this country must own, and be able to manage, a good boat.

Geology.—The general geology of the country from Sumdum, on the south, to Berners Bay, on the north (the country examined by the writer), is as follows: The main or higher ranges of mountains, located at some little distance from the coast, are principally composed of granite and syenite. Flanking these mountains are those which descend to, or nearly to, the shore, and these latter mountains consist of slates and schists which are probably Carboniferous. The slates and schists stand at an average angle of about 75 degrees from the horizontal, and are intersected in places by dikes of diorite, porphyry, syenite, and greenstone. These dikes have played an important part in the mineralization of the country, in fact the great Alaska-Treadwell vein is simply an altered dike. Numerous small faults are encountered, and some throws of several hundred feet were noticed. Interbedded with the slates and schists occasional beds of quartzite are encountered. The country has been the scene of most extensive glacial action, and many of the present inlets and channels are due to this cause.

The Ore Deposits.—Mining in this section has so far been confined to the operation of a number of low-grade gold quartz deposits, and some placer mining in a small way, the only extensive placer mining operations being those of the American Gold Mining Company in Silver Bow Basin.

The most prominent mine and the largest producer has been the Alaska-Treadwell, located on Douglas Island, opposite Juneau, and the connected companies known as the Alaska-Mexican, the Alaska-United, and the Ready Bullion. All of these mines are located on the same great vein or dike, which is in places fully 400 feet in width. The vein would appear to have originally been an intrusive dike of syenite which has since been shattered and altered by ascending solutions from which the quartz, calcite, pyrite, and gold have been precipitated. Subsequent to the intrusion of syenite there was an intrusion of gabbro, which has been altered to greenstone and now forms the hanging wall of the deposit, black slate forming the foot wall. The vein is from 50 to over 200 feet in width and contains a number of horses of barren rock. The ore appears to occur in chutes which vary in extent and value, the richest ore being encountered in the Ready Bullion claim, where the vein passes under Gastineau Channel. Near here are situated the plants of the Alaska-Treadwell and the Alaska-Mexican Gold Mining Companies. For a very interesting description of this remarkable deposit the reader is referred to Becker's report in the Eighteenth Annual Report of the Director of the U. S. Geological Survey.

The continuation of the Treadwell vein to the north of the Alaska-Treadwell properties has been opened in a number of places and worked to some extent, but nothing is being done at present, as the ore is said to be too low grade to pay. There are a number of quartz veins to the northwest of the Treadwell which have been prospected in a small way; but none of them have, as yet, advanced beyond the prospect stage.

Silver Bow Basin, near the head of Gold Creek, is about three miles a little north of east from Juneau. On the divide which

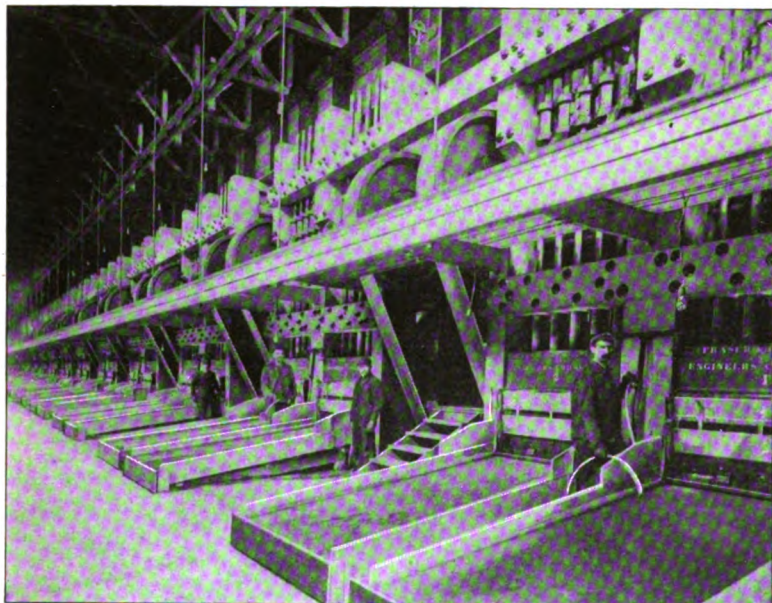


FIG. 2. BATTERY FLOOR ALASKA-TREADWELL MILL.

interest may be seen in this way, but to fully appreciate the sublime scenery a stop should be made for a few days at Juneau, or some other point, and a few mountain climbs should be undertaken. It is only when one has ascended a few thousand feet above the beach and looks over the majestic vista of mountains, glaciers, and water that the true and sublime character of the scenery is appreciated.

Climate.—The idea seems to prevail that Southeastern Alaska is a cold country; this is a mistake, as, owing to the influence of the Japan current, to which the shore line is subjected, the climate is comparatively mild. I am informed that the mercury seldom falls below zero at Juneau and that a temperature of 80 degrees in the shade is exceptional, although I have known the thermometer to register that high on a bright sunny day. However, bright sunny days are an exception in the vicinity of Juneau and Sitka, where the rain and snow fall is enormous. As you pass away from the coast, into the interior, the climate changes; the precipitation of moisture is much less, and extreme cold is experienced in the winter months as well as very warm weather in the summer season.

Character of the Country.—Adjacent to the sea and the various inlets, passages, bays, etc., the country is mountainous and rugged; the mountains frequently extending right down into the water. Many of the glaciers also terminate in the sea. The shore and the mountains up to an elevation of about 2,000 feet (timber line is located at this altitude), except where snowslides prevail, are covered with a magnificent growth of fir and spruce timber, and

separates Silver Bow Basin from Sheep Creek Basin there is a glacier which formerly extended to the mouth of Gold Creek. This glacier excavated the considerable depression where is now Silver Bow Basin. The depression was subsequently occupied by a lake which was separated from the lower part of the creek by a rock divide. These lake beds are auriferous and constitute the placer mine of the American Company, which has been worked by hydraulic mining for the past nine years and is said to have produced about \$350,000 in gold bullion. The gravel is rounded to a very slight extent and many of the rock fragments are angular. The beds contain numerous pebbles and boulders of white gold-bearing quartz, and frequently rock boulders of from 5 to 8 feet in diameter. Most of the placer gold has doubtless come from the quartz deposits located on the hillsides to the south of the placer. In fact, it was the rich bench placers, located on these hillsides, which first attracted attention to Silver Bow Basin.

The quartz deposits of Silver Bow Basin occur in schists, which have a general strike of N 60° W and a dip of about 60° to the northeast. The veins consist of quartz stringers and lenses, many of the smaller ones being intercalated in the schists in conformity to their cleavage, and many of the larger quartz lenses occurring in the same manner. The most numerous, as well as the largest stringers, cut upwards into the schists, and have evidently been opened by normal faulting. The quartz stringers vary from less than $\frac{1}{4}$ of an inch to over 4 feet in width, and are very irregular, feathering out on their edges to nothing, although one lense is usually succeeded by another. This mineralized zone is about 2,000 feet in width, and can be traced from near the mouth of Gold Creek, through Silver Bow Basin, across the divide over into Sheep Creek Basin. The largest of the open cuts or quarries are on the Alaska-Juneau, the most extensively opened of the Silver Bow Basin quartz properties.

The quartz deposits of Sheep Creek Basin are similar in character to those of Silver Bow, being on the same mineralized zone. However, the lenses here, especially in the Silver Queen and Glacier mines, which are the most extensively developed properties, are larger and appear to be more concentrated, or restricted to a narrower area, the country rock being carbonaceous slate. The ores also differ in character, silver predominating in the Silver Queen Glacier ores, whilst the ores of Silver Bow Basin carry principally gold and but little silver, zinc, or lead.

The Berners Bay district is about 40 miles northwest of Juneau in a direct line, and about 60 miles from Juneau by steamer. The main development as yet has been on Sherman Point, which is situated between Berners Bay and the Lynn Canal. The principal mines are the Comet, the Kensington, the Jualin, the Alaska-Indiana, and the Mellen. The Jualin and the Alaska-Indiana are located on the Berners Bay side and are quartz veins in black Carboniferous slate. Crossing over the divide to the Lynn Canal side the formation changes to diorite, syenite, and granite, which are intersected by a number of eruptive dikes. The white quartz veins vary from 1 foot to over 60 feet in width and appear to be well-defined fissure veins. The most extensive workings are on the Comet, which is an auriferous quartz vein averaging about 3 feet in width. This mine has been opened to a depth of 470 feet, and is said to have produced \$463,000, of which \$443,000 was in the form of gold bullion (average fineness about 825) and \$20,000, as sulphide concentrates. This mine has produced some beautiful specimens of free gold quartz; the gold occurring as wire and crystalline gold. During the summer of 1900 the average monthly product of the Jualin mine was stated to be about \$12,000, of which about \$9,500 was in the form of bullion the balance being sulphide concentrates.

The Kensington mine has not been sufficiently developed to enable one to judge exactly as to the character of the deposit. It appears to be a mineralized zone of more or less irregular quartz stringers and lenses in diorite. The zone is from 30 to 60 feet in width and the quartz carries considerable auriferous pyrite and pyrrhotite. The gold is intimately associated with the sulphides, over 90 per cent. of the value of the ore being recovered in the mill concentrates.

There are a number of other quartz veins in the district, but none of them have been developed to any great extent. The

Johnson Lode is the most remarkable vein of the district. Its outcrop is fully 60 feet in width and it can be traced for a distance of over 2,000 feet on its strike, which is nearly east and west. The vein traverses the granite and diorite and is associated with a greenstone dike, which appears to form one of its walls.

On the eastern side of Berners Bay there are a number of quartz veins, in slates and schists, the outcrops of which can be seen in a number of quite widely separated places; but there has not been sufficient prospecting on the veins to enable one to judge as to their permanency or value.

The Ores.—The gangue minerals of the Alaska-Treadwell, etc., mines on Douglas Island, are not numerous. Quartz forms the principal ingredient, and it is frequently accompanied by calcite. Pyrite is the most abundant associated sulphide, although chalcopyrite and mispickel are occasionally encountered. Pyrrhotite, galena, and zincblende are rarely encountered. About 65 per cent. of the total mill recovery is in the form of bullion, the other 35 per cent. being recovered in the form of vanner concentrates, which



FIG. 3. PROSPECTORS' CABIN AND TUNNELS, BERNERS BAY DISTRICT.

are principally iron pyrites and quartz. The ore varies greatly in value; but the mill recovery will probably average in the neighborhood of \$2.50 per ton.

The gangue minerals of the Silver Bow Basin quartz mines are principally quartz and calcite with some siderite, and small amounts of pyrite, galena, and zincblende. The sulphides in these ores will probably not exceed 3 per cent., and less than 10 per cent. of the values recovered in the mill are in the form of concentrates. These concentrates are principally iron pyrites and quartz, and seldom exceed \$30 per ton in value. The ores vary greatly in value; but as delivered at the mill, after sorting from the waste, will yield from \$4 to \$5 per ton.

The ores of the Sheep Creek Basin are principally argentiferous, the minerals encountered being principally quartz with some pyrrhotite, zincblende, galena, and mispickel; a little pyrite and occasionally native and ruby silver. The galena is argentiferous

and gives the ores their chief value. The pyrrhotite, pyrite, and blende carry some gold. The Silver Queen and Glacier mines are said to have produced in the neighborhood of \$300,000 of which about \$210,000 has been in the form of concentrates and about \$90,000 in the form of bullion (gold fineness about 80, and silver fineness about 860).

The ores of the Berners Bay district are quite variable in character but the principal gangue mineral in all of the mines is quartz. The ore of the Comet mine carries small amounts of pyrite, chalcoppyrite, galena, and zinblend. However, the value of the ore is in the free gold, the amount of sulphides encountered being very slight. This mine is said to have produced in the neighborhood of \$450,000, about 95 per cent. of the product having been recovered in the form of amalgam on the mill plates. Many of the other veins of the district present ores of the same general character.

The ores of the Kensington and Johnson veins are principally quartz with associated pyrite and pyrrhotite, and occasionally chalcoppyrite, carrying gold. In the case of these deposits the gold appears to be intimately associated with the sulphides and, from tests made by the writer, less than 10 per cent. of the gold contents can be saved by ordinary battery and plate amalgamation. However the ores are well adapted to concentration.

The quartz veins located to the east of Berners Bay carry considerable mispickel and some little iron and copper pyrites. In many places, on the surface, free gold is found.

The Mills.—The ores being mostly free milling gold quartz the method of treatment is stamp milling followed by concentration of the sulphurets on Frue vanners. The ores so far as developed are low grade—varying in value from \$2 to \$12 per ton—and must consequently be cheaply mined and milled in order to return a profit. This condition has resulted, especially in the case of the Alaska-Treadwell and the allied companies, in the erection of large modern mills which are largely operated by water power; the power being generated by Pelton wheels. These companies have a total of 820 stamps of which number about 500 are kept in operation throughout the year. Some of the mills are equipped with auxiliary steam plants and a few of the mills are operated by steam exclusively. The mills equipped with steam plants are

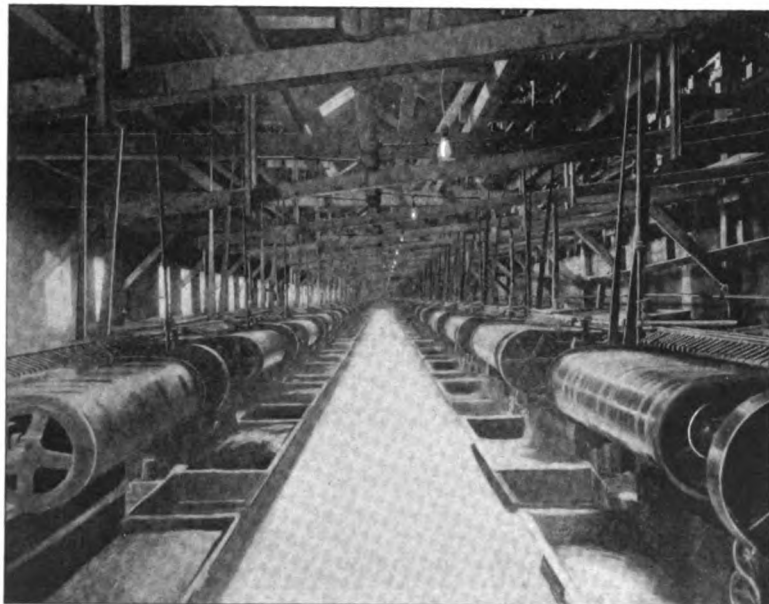


FIG. 4. VANNER FLOOR ALASKA-MEXICAN MILL.

kept in operation throughout the year; but the new Alaska-Treadwell 300-stamp mill is operated exclusively by water power, and consequently has to shut down when the water fails. This is a thoroughly modern mill, the stamps weighing 1,050 pounds and crush on an average about $4\frac{1}{2}$ tons of ore per 24 hours. The mortar blocks weigh 7 tons and rest on concrete foundations. One-half of the battery floor is illustrated in Fig. 2, whilst Fig. 4 illustrates the vanner floor of the Alaska-Mexican mill.

The Alaska-Juneau company are operating a 20-stamp mill which is equipped with eight Frue vanners. The 20-stamp mill of the American Company, located near the mouth of the Silver Bow placer drain tunnel, has not been operated for some years.

At Berners Bay there is the 40-stamp mill of the Comet. This mill is equipped with a Frue vanner and a canvas plant, and is connected with the wharf at Seward City (on the Lynn Canal) by a narrow-gauge railroad $2\frac{1}{2}$ miles in length. This railroad is of

some interest as it is the pioneer railroad of Alaska. The Jualin Company has a 10-stamp mill, and the Mellen Company also has a 10-stamp mill, both equipped with Frue vanners.

In Sheep Creek Basin the Silver Queen Glacier mines have a 25-stamp mill and a modern vanner and canvas plant. The stamp mill is about a mile from the beach where the wharf, vanner, and canvas plants are located.

General Conclusions.—Owing to the topography of the country, and the conditions as outlined above, prospecting is most difficult and is accompanied with many hardships and expenses which are not ordinarily encountered. There are a number of auriferous quartz deposits which have been located, and many of them are favorably situated adjacent to tide water. However, in most instances the quartz is low grade, and many of the deposits appear to be of uncertain value and pockety. The only mining operations which have so far proven highly remunerative have been those on Douglas Island. It would appear that there is a good field in this section for exploration companies of ample capital and large experience; but for the prospector, or the small capitalist, the field would not appear to be an inviting one.

ELECTRICAL TRANSMISSION OF POWER

From Mines—The Methods and Principles Which Govern It and Limit the Profitable Distance to Which It May Be Applied.

By Prof. F. C. Caldwell.*

There has been some discussion with regard to the practicability of developing electrical power at coal mines, and transmitting it to points where it is needed, by which means the usual method of transportation of the coal would be replaced. I have therefore thought that it might interest the members of the Institute to hear something of what is now being done in long distance power transmission, together with some figures as to the distance to which such transmission might be commercially practicable.

To be sure of making myself intelligible, I must first remind you of some important facts connected with electrical power.

These can be best illustrated by comparison with similar phenomena in hydraulics. Here, we can transmit a given power either by a large flow of water under a low pressure, as for instance in a canal or large sluice with a fall of a few feet only, or if the necessary pressure is available, we can use a small flow under a high head, as is done in most of the hydraulic work of the West. The same two conditions of power transmission are open to us in the electrical field. We can use a large current at a low pressure, or a small current at a high pressure; that is, a current of many amperes under a pressure of only a few volts, or vice versa. In this case for a given power, the product of volts times amperes, will be always the same. Thus, 100 H. P. can be transmitted with about 750 amperes at 100 volts, 75 amperes at 1,000 volts or 7.5 amperes at 10,000 volts.

Again, as it would take a much larger waterway to transmit 100 H. P. with a 10-foot fall than with a 100-foot fall, so it will take a much larger wire to transmit 100 H. P. at 100 volts than at 500. Here, indeed, we have a very simple and convenient relation between the wire sizes; for if the losses, and hence the efficiencies, are to be the same in both cases, the wire must be 25 times as large at 100 volts as at five times that voltage or 500 volts; that is, as the pressure increases the size of wire decreases as the square of the pressure.

It is this fact that makes it practicable to transmit power at high pressure to long distances. Tables I and II illustrate the working of the above law in two cases. In the first case it will be noticed that the wires specified for 110 and 50,000 volts are both entirely impracticable; thus 110 volts is far too low and 50,000 volts is higher than necessary. In the second case it is plain that even 10,000 would require too much copper while 50,000 gives such a small wire as to indicate that a lower voltage could be used.

TABLE I.

SIZES OF WIRE NECESSARY TO TRANSMIT 100 H. P. 1 MILE WITH 10% LOSS IN THE LINE.

Volts.	Area Circular Mils.	Area Square Inches.	Approximate B. & S. Wire.	Diameter as Single Conductor.
110	7,162,100	5.68	34, No. 0000	2.67"
225	1,712,000	1.35	8, No. 0000	1.81"
500	846,600	.2724	2, No. 0000	.59"
1,000	86,650	.0681	0	.296"
10,000	866	.000681	20	.0296"
50,000	34.6	.0000272	34	.0069"

*A paper read before the Ohio Institute of Mining Engineers, Feb., 1901.

TABLE II.

SIZES OF WIRE NECESSARY TO TRANSMIT 1,000 H. P. 100 MILES WITH 10% LOSS IN THE LINE.

Volts.	Area.		B. & S. No.	Diameter Single Wire.
	Circ. Mils.	Sq. In.		
1,000	86,650,000	.681	400, No. 0000	.928"
10,000	866,500	.0681	4, No. 0000	.928"
50,000	84,600	.00272	No. 5	.18601"

The area of the wire increases directly with the distance and with the power transmitted, and decreases in the same ratio that the allowable loss is increased. Thus if 20% loss were permitted, the above sizes would be halved. The wire area for a 2-wire system is calculated by the formula,

$$\text{Current} = \frac{746 \times \text{Horsepower}}{\text{volts}}$$

$$\text{Area in circular mils} = \frac{11 \times \text{length of wire (ft.)} \times \text{current}}{\text{volts} \times .01 \times \text{allowable loss in \%}}$$

$$\text{Area in square inches} = \frac{\pi \times \text{area in circular mils}}{4 \times 1,000,000}$$

The pressures which it is practicable and desirable to use in transmission are higher than those which can be used in motors, lamps, etc., and often higher than can be handled safely in the generating dynamos. Here comes in another important point, namely the distinction between direct and alternating currents. If we should place an ordinary pump in a large circle of pipe and pump water through this pipe, we could transmit power to any point of the circle and use it by placing a turbine at that point. This would correspond to the direct current because the flow would all be in one direction. Now stop up the valve in the piston of the pump, and take out the other valve and we shall have a condition similar to that in the alternating current circuit, where the flow is alternately first in one direction and then in the other. The most notable difference is that in the electrical case, the reversal of the current happens generally from 60 to 120 times per second, whereas in the case of the pumps, it could only be a few times a minute. Alternating current has the very important property that its pressure can be changed by simply passing it through a coil of wire in an iron box, from another coil alongside of which comes a current at the changed pressure. The two coils are properly proportioned and are surrounded by a mass of iron in thin sheets. This arrangement is called a transformer, and the loss of power in it is only about 3 to 6% according to size. For instance, by its use 100 H. P. can be changed from a current of about 7.5 amperes at 10,000 volts to 75 amperes at 1,000 volts, or 750 amperes at 100, or the operation can be reversed and the change made from 100 to 1,000 or 10,000 volts. It follows that by the use of alternating currents we can generate our power at such a pressure as best suits, transform to a higher pressure, if necessary, and then after transmitting to a distance transform down again to a voltage which is best adapted for the use to which the power is to be put. We can then also change to direct current if necessary, by passing through a so-called rotary converter, which is a machine built for both alternating and direct current.

At Niagara, there is such a plant; here the power is generated at 5,000 volts, and distributed to nearby points at that pressure, but for transmission to Buffalo, 20 miles away, the current is transformed up to 10,000 volts.

Direct-current voltages cannot be transformed in this way, and so while such current is almost always used for railway work and usually for incandescent and arc lighting, it is very seldom used for long distance transmission.

It may next be asked what constitutes a limit to the increase of the pressure and corresponding decrease of size of wire. As you know, it is always necessary to insulate electrical conductors, and with high pressure this becomes difficult. Only a few years ago, pressures higher than 1,000 were unusual, and 5,000 was considered very high. During the past ten years, however, a great development in this direction has taken place, till now a recent statement from one company shows that they have installed 34 plants using 10,000 volts or over; in seven of these the pressure is 20,000 or over, in two it is 30,000, in one 33,000, and in two 40,000. The greatest distance is 80 miles in the 33,000-volt plant, and there are five plants transmitting 40 miles or over. Up to this point the problems of insulation have been satisfactorily solved, and with no very radical differences from the methods in use for lower pressures. In the transformers, the use of oil as an insulator together with considerable space between the coils and the surrounding iron, make even much higher pressures easily possible, though adding decidedly to the cost, especially in the smaller sizes. In the transmission line the only new require-

ments are greater distances between the wires and larger and more carefully made insulators. Under these conditions, systems up to about 40,000 volts work well, at least in pure atmospheres. But at about 50,000 volts a new phenomenon comes in which seems likely to set a definite limit to the increase of pressure. It is the leakage of current directly across through the air from wire to wire. With increase of pressure above about 50,000 volts this leakage increases very rapidly and is accompanied by a hissing sound and luminous halo around the wire. The condition of the weather, apart from actual fog, rain, or snow, seems to have little effect either upon this leakage or upon that over the insulators; which latter need in no case be a serious item. Rain and snow increase the loss but not to any great extent.

With this very brief review of what has been and can be done from the point of the engineer, let us now consider the question in hand from the financial side. To simplify the problem I shall ask you to grant that there is a market for electrical power in all cities of any size, which makes it profitable to burn coal and generate electricity in the city. With this to start from, the question becomes simply under what circumstances, if any, would it be cheaper to place the generating plant at the mine instead of in the city. We then have to balance cost of coal transportation, including haulage, on the one hand against cost of electrical transmission on the other, due allowance being made for the possible use of a lower grade of coal at the mines, and for lower cost of land, lower taxes, and perhaps better facilities as to condensing water. Any such discussion of the subject must, of course, be very general in its character, for every particular case would have its peculiar conditions which would make it different from every other.

The following will be assumed as figures upon which to base our calculations. The figures upon electrical apparatus and installation have been kindly furnished by Mr. Harford Stewart, of the General Electric Co., and Mr. J. A. Erner, of the Erner Construction Co.

Transformers	\$7.50 per horsepower.
Rotary converter	\$11.00 per horsepower.
Generators	\$15.00 per horsepower.
Steam plant	\$50.00 per horsepower.
Pole line with insulators and stringing of wire	\$640.00 per mile.
Bare copper wire	20 cents per lb.
Freight on coal, 10 miles	40 cents per ton.
Freight on coal, 20 miles	45 cents per ton.
Haulage of coal	15 cents per ton.
Full load efficiency of transformers	96%.
Average efficiency of transformers	94%.
Full load efficiency of line	90%.
Average efficiency of line	95%.
Interest	5%.
Depreciation	10%.

We will now consider three cases which will show something of the probable range of successful operation of electrical transmission. A three-phase system, requiring 3 wires, will be used.

FIRST CASE.

2,000 horsepower transmitted 10 miles at 12,000 volts.
Additional cost for electrical transmission plant.

2,000 horsepower, step-down transformers	\$15,000.00
320 horsepower, necessary increase in generator capacity	4,800.00
320 horsepower, necessary increase in steam plant capacity	16,000.00
10 miles pole line, with insulators and stringing	6,400.00
30 miles No. 2 wire, 1,064 × 30, 31,920 lb. at 20 cts.	6,400.00

	\$48,600.00
Interest and depreciation at 15%.....	\$ 7,800.00
Interest and depreciation, per H. P. year.....	8.65

Saving on coal transportation.

Taking 5.5 lb. coal per H. P. hour, and assuming as a basis of comparison that the average time per H. P. is 310 days of 10 hours, or 3,100 hours.

$5.5 \times 3,100 = 17,000 \text{ lb.} = 8.5 \text{ tons coal per H. P. year,}$
upon which is saved 40 cts. freight and 15 cts. haulage.

Therefore, $8.5 \times 55 \text{ cts.} = \$4.67.$

But, since only 89% of the power generated at the mines would have to be generated at the end of the line, this becomes

$$\$4.67 \times .89 = \$4.15.$$

Hence, total saving per H. P. = $\$4.15 - \$3.65 = 50 \text{ cts., or}$
\$1,000 on the whole plant.

SECOND CASE.

2,000 H. P. transmitted 20 miles.

Machinery as in first case	\$35,800.00
20 miles pole line	12,800.00
60 miles No. 00 wire, 2,129 × 60, 127,740 lb.	25,500.00

	\$74,100.00
Interest and depreciation at 15%.....	\$11,100.00
Interest and depreciation, per H. P. year.....	5.55

Saving in transportation of coal.

8.5 tons at 60 cts. \$5.10

$\$5.10 \times .89 = 4.55$

Loss per H. P. per year $\$5.55 - \$4.55 = \$1.00$ by electrical transmission.

THIRD CASE.

1,000 H. P., 10 miles.

Machinery, one-half of amount of Case I	\$17,900.00
10 miles pole line	6,400.00
30 miles No. 5 wire	3,200.00

	\$27,500.00
Interest and depreciation at 15%	\$4,120.00
Interest and depreciation per H. P.	4.12
Saving in coal transportation, as in Case I	4.15
Saving by electrical transmission, 8 cts. per H. P. year.	

These three cases would seem to indicate, first, that electrical transmission from mines is out of the question for distances greater than twenty miles; second, that if the amount of power transmitted be great enough, transmission to about ten miles may be profitable. In some other cases the "power factor" or ratio of average to maximum power may be greater, which would help the electrical side of the case; again, saving in taxes and in first cost of land may be important; or an opportunity to run condensing may be a factor.

In all this, it is assumed that the same grade of coal is used at the mines as is used at the end of the line; and if a cheaper coal is available, the difference should be credited to the electrical transmission.

BRUSHY MOUNTAIN COAL MINES.

Operated by the State of Tennessee—A Description of the Coal, the Methods of Mining and the Haulage Plant.

Written for MINES AND MINERALS, by A. W. EVANS.

In accordance with the act of 1893, chapter 78, sections 1 to 17 inclusive, which act is entitled as follows: "An act to provide for the erection of a penitentiary and appurtenances, upon improved and modern plans, in which to keep and maintain state convicts; to provide for the utilization of convict labor therein and upon farming land and in a coal mine or mines, and for the purchase of the property necessary for the aforesaid purposes and to prepare for the abolition of the convict lease system in Tennessee," the Governor appointed Hon. R. G. Morgan, of Shelby County; Hon. D. K. Young, of Anderson County, and Hon. M. H. McDowell, of Franklin County, who, in conjunction with State Geologist J. M. Safford, made a thorough investigation of numerous tracts of coal lands in the state, which resulted in

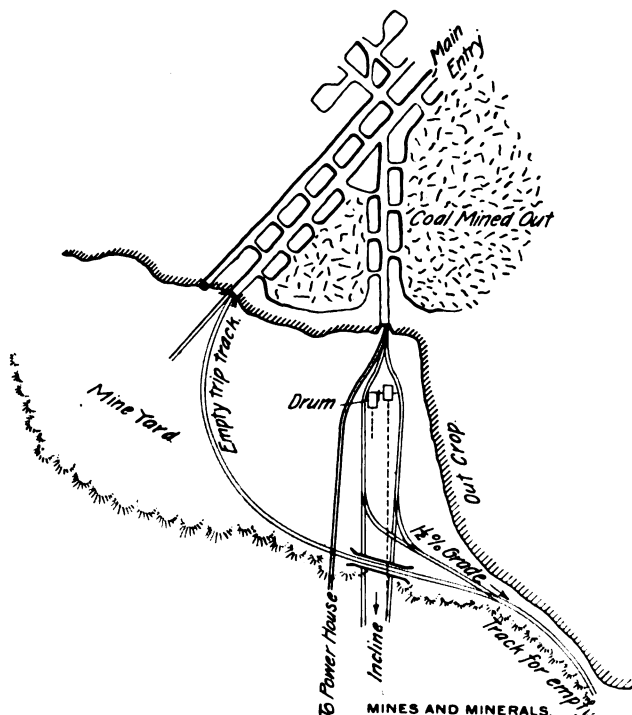


FIG. 1. PLAN SHOWING LOCATION OF MINE OPENINGS AND HEAD OF INCLINE.

the purchase from the East Tennessee Land Co. of 9,000 acres in Morgan County, paying \$80,000 for said tract of coal land.

The Brushy Mountain coal field, so called from the fact that the Brushy Mountain coal mines are situated in the geological and commercial center of it, is twenty miles northeast of Harriman, and midway between the towns of Oliver Springs and Wartburg.

The series of mountains in this district are known as palmate,

having high crests, reaching 3,010 feet above mean tide and tapering out in long spurs forming the valleys of Crooked Fork, Flat Fork, New River, and Emory river.

The drainage of the Brushy Mountain coal field may be divided into four water sheds. On the north, New River, on the east, Crooked Fork, on the south, Flat and Beech Fork, and on the west the Emory river and its tributaries.

The mine was opened in 1894 in a small cave between Indian Knob and Frozen Head Mountain. The coal at this point has

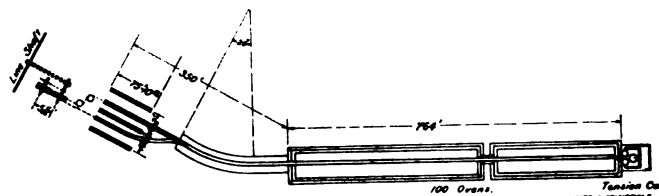


FIG. 2. PLAN OF HAULAGE ARRANGEMENTS AT COKE OVENS.

an elevation of 1,616.6 feet above tide water. The coal measures lie approximately horizontal, having a slight dip eastward, probably 10 feet to the mile, and in this section have a total thickness of 3,000 feet. There are eleven seams of coal, the only two of any consequence being the Brushy Mountain and the Dean seams. The Brushy Mountain seam underlies about 6,000 acres of the 9,000 acre tract and presents a pleasing uniformity of quality and thickness, averaging about 42 inches, with a fire clay parting which seems to be persistent. This parting varies from 4 inches to 18 inches, but can be mined with the pick up to a thickness of 6 inches.

The coal is a lustrous black, breaking with a cuboidal fracture and does not weather rapidly. The cleavage planes are well defined, with a general direction of N 70° W. The coal has been subjected to a chemical analysis with the following result:

Fixed carbon	82.81
Vol. matter	82.82
Ash	4.66
Sulphur	.51
	100.00

At an elevation of 600 feet above the horizon of the Brushy Mountain seam, the Dean coal occurs, correlated with the famous Dean coal of Kentucky, having a thickness of 50 inches to 144 inches. This coal contains considerable slate and would have to be thoroughly washed and prepared for coking. It is a bright, black coal, high in ash and low in sulphur. It mines in large, firm lumps and by a system of sizing and washing will make an excellent coke. The analysis is as follows:

Carbon	88.76
Vol. matter	88.29
Ash	7.13
Sulphur	.09

The Brushy Mountain Mine is developed on the double entry system, the main entry bearing N 87° 15' W on a 1% grade in favor of loads. Cross entries are driven at right angles to the main entry to the right and left, 300 feet apart. The coal is worked out by rooms, having a width of 25 feet and with a 20 foot pillar left between rooms. In the exploitation of this system $\frac{1}{11}$ of an acre is mined in driving up a room and $\frac{1}{11}$ of an acre left in the pillar, giving 3.2 rooms and pillars per acre.

There are approximately 3,194 acres of workable coal in the Brushy Mountain seam on State property or 12,775,000 tons. Figuring on an output of 1,000 tons per day, this coal will last thirty-five years.

The main No. 1 entry can be driven 2.7 miles to the western boundary of the property. The main entries are equipped with 35 lb. rails and the rooms with 16 lb. sections.

The mining car used is of the Watt pattern with a capacity of 28 cubic feet, carried on two pairs of loose wheels 12 inches in diameter, spaced 20 inches on centers. The dimensions of car are as follows: 3 ft. 9 in. at top, 2 ft. 7 in. at bottom, 20 in. deep and 7 ft. 2 in. in length.

Ventilation is produced by a 15 foot Crawford and McCrimmon fan. The physical condition of the mine is excellent and worthy of emulation.

The coal is brought to head of the incline by electric motors, the system of haulage being known as the third rail system. An I beam is placed on built up pieces of well seasoned pine in the center of the track, the top of the channel being 6 1/2 inches above top of tie, Fig. 3, and in a recess in the center pieces the trolley wire is securely fastened. This consists of a flat piece of copper 1/4 in. X 1/2 in. A traveling wheel on the motor comes in contact with the copper strip thus supplying current to motor. Four

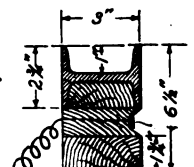


FIG. 3.

grip wheels on bottom of motor frame engage the I beam. These wheels are thrown against the beam by a combination of toggle joints and a large hand wheel. The motors pull in this system by adhesive and not tractive force, in consequence of which they are smaller and can be more easily handled than the overhead trolley motors. The motors measure 3 feet high by 4 feet long and pull a trip of thirty empty cars up a $1\frac{1}{2}\%$ grade at a speed of about 8 miles per hour, the empty car weighing 1,000 lbs. Two 50 H. P. motors are in use hauling 1,100 tons per day (see Fig. 2 for arrangement of tracks on mine yard). The current is furnished by a 260 H. P. engine and a dynamo with a capacity of 150 K. W., made by Ridgeway Dynamo & Engine Works, Ridgeway, Pa.

The main haulage entry is lighted by incandescent lamps. The power house is located at foot of incline 755 feet from portal of mines. The boiler plant consists of two 100 H. P. boilers, built by the Lookout Boiler and Mfg. Co., Chattanooga, Tenn. The original boiler plant consisted of two boilers 44 in. $\times$ 14 ft., spaced 66 inches on centers, but they were found inadequate for the service.

The tippie, power house and washer are shown in photograph looking down the incline. After the loaded cars are delivered at mine yard, they are lowered to the tippie, in trips of eight cars, by a double track gravity incline 755 feet in length. This plane approximates very closely the curve of a cycloid, the degrees of inclination being as follows: near head of plane $31\frac{1}{2}^\circ$, at center $18\frac{1}{2}^\circ$, near lower terminal $15\frac{1}{2}^\circ$. In the make up of trips, a bridge consisting of a section of 1 inch steel rope, with socket and chain at each end is carried over the top of the cars and securely fastened to the main ropes and last car in the trip. The running time of trip is 30 seconds. The drums are double geared, 8 feet in diameter by 6 feet long with wood lagging. The rope used is of plough steel 1 inch in diameter—two lengths of 900 feet each. After the cars are delivered at tippie they are run over a Wilson and Mitchell patent tip. They are tipped at the rate of six cars per minute, then back switched where they run by gravity to the point for attaching to rope. The coal is delivered to shaking screens 15 feet long by 3 feet in width, one above the other; the top plate having 3 inch perforations and corrugated, the bottom plates with $\frac{3}{4}$ inch perforations. The screens are driven from the same shaft, the eccentrics being keyed on shaft at 180° apart, thus taking up the jar caused by the vibrations of the screens. They are driven at the rate of 66 revolutions per minute by an independent engine.

The coal from top screen goes to railroad cars for shipment. The coal passing through the lower screen falls into an elevator boot from which point it is taken to a retention bin where it is carried to the washer by a bucket elevator of special design. The coal is thoroughly washed by a 400 ton Robinson washer, installed by the writer. The coal after flowing from washer is carried over two sets of screens elevated at the discharge end 12 inches from the horizontal. The top screen consists of a steel plate, 54 inches $\times$ 144 inches $\times$ $\frac{1}{4}$ inch thick with $\frac{3}{4}$ inch perforations $\frac{3}{4}$ inch from center to center. The lower screen consists of a sheet of No. 20 G. manganese bronze of same dimension as top plate having $\frac{1}{16}$ inch perforations, 72 per square inch. Two drag conveyors carry the coal along these screens to the discharge point, where it is discharged into an elevator that transports it to settling bin. This bin is 75 ft. 10 in. in length by 32 ft. 4 in. in width by 15 ft. 10 in. in depth and has a capacity of 700 tons. The washer and coal-handling machinery are actuated by a 60 H. P. center crank engine with 13 in. $\times$ 16 in. cylinders built by the Wheland Machine Co., of Chattanooga. The approximate cost of installing the washer and coal handling machinery was \$7,000; coal tippie, trestle, dump and screens, \$2,944; incline, drums, foundations and rope, \$993.

The coke plant consists of two batteries, 68 ovens in one and 32 in the other—the continuity being broken by the wagon road to mines. The ovens are of the beehive type, 12 feet $\times$ 7 $\frac{1}{2}$ feet, area of oven 113 square feet. They are spaced 14 feet on centers and staggered. The bank of No. 1 battery is on a $1\frac{1}{2}\%$ grade, while that of No. 2 is 1%. The retaining walls are built of bluish sandstone with a 10 inch coping. This battery of ovens cost approximately \$325 per oven.

The approach to ovens is by a trestle 300 feet long on a 20° curve. The track is in center of battery and is laid with 60 lb. rail and supported by brick piers 18 inches square. A cast cap fits over top of pier with lug to engage base of rail. Tie bars

are spaced 7 feet apart—thus insuring a perfect alignment of tracks. The water for ovens is delivered through a 6 inch spirally riveted steel pipe, 4,280 feet in length, from reservoir to upper end of ovens. At this point the water is distributed to each side of battery of ovens by a line of 4 inch cast pipe, a 1 inch stand pipe projecting above the main at intervals of 28 feet. The Cadman hose valve is used on top of the stand pipe and fits in a recess of retaining walls thus protecting the valves from the carelessness of coke drawers. The pressure at ovens is between 30 and 40 lbs.

The larry is of the double discharge type and is actuated by an endless rope haulage, the larry being attached to the rope by a Carr cable grip. The plant consists of one 3 grooved sheave 48 inches in diameter and one double grooved sheave 42 inches in diameter, spaced 5 $\frac{1}{2}$ feet on centers. On the shaft of the 42 inch sheave is a 12 inch clutch sprocket speed 108 revolutions per minute, connected by chain to a 48 inch sprocket on shaft of 48 inch sheave. From the main line shaft of the washing plant motion is transmitted by four strands of manila rope to shaft of 42 in. sheave proper. Deflecting sheaves are used to guide the rope in its place under settling bin and cast sheaves bolted on to tie bars of oven track, Fig. 2. At lower end of ovens the rope, which is of $\frac{3}{8}$ inch steel, is carried around a 48 inch sheave placed horizontally in a tension carriage constructed of 12 in. $\times$ 12 in. oak carried on two pairs of loose wheels. This carriage is properly weighted and keeps the rope taut. This arrangement of haulage is a very simple and effective one. Transportation for the output is furnished by the Harriman and North Eastern Railroad, extending from Harriman to Petros, a distance of twenty miles. At Harriman the coal and coke is delivered to the C. N. O. and T. P. Railroad and a branch of the Southern known as the Walden Ridge Railroad.

The prison building at the State mine is built in the form of



FIG. 4. TIPPIE, POWER HOUSE, AND WASHER, BRUSHY MOUNTAIN MINES.

an L. The front or main wing is 205 feet long, four stories high and 31 feet in width in the clear. The rear or west wing is 17 $\frac{1}{2}$ feet by 31 feet and three stories high. The walls are built double—the outside being of rough plank 1" thick, set perpendicularly and battened. The inside is of dressed material and put on diagonally, and between the two is a layer of heavy tar paper. All floors are doubled, with tongue and grooved flooring. The windows are securely barred with 1 inch round iron, thus rendering the building safe. The first floor of west wing is used for a bath room. Here the convicts can take a shower bath with either hot or cold water. The first story of main building is used for a dining room. This room has a cement floor. The hospital, located within the prison enclosure, contains one ward 25 ft. $\times$ 20 ft. for whites and one 40 ft. $\times$ 20 ft. for colored, affording accommodation for a total of twenty-five men. Each ward is equipped with a bath room and with hot and cold water provided. The building also contains an office for physician, laboratory, private office and operating room. All buildings are lighted with electricity, the power house being in the prison enclosure. The sanitary conditions of this prison are as perfect as it is possible to arrange without a system of sewers.

The cost of convict maintenance for 451 men is as follows:

Rations	\$0.1029
Clothing	.0271
Transportation	.0075
Control	.1123
Expense	.0168
Total	\$0.2666 per day.

Great credit is due Hon. W. M. Nixon, Chairman of Board of Prison Commissioners, and Mr. J. S. Hill for their untiring efforts to make the Brushy Mt. plant a successful one both technically and financially.

THE BAT GUANO CAVES

Of Texas—Enormous Caverns Containing Valuable Deposits of Fertilizer Some of Which Are Being Worked.

Written for MINES AND MINERALS, by William B. Phillips, Ph. D.

The ordinary leather-wing bat, whose family name is Cheiropter, has congregated in some of the limestone caves of Texas for a great many years, and in very large numbers. It would appear as if all the bats of the country came to Texas and sojourned, for a while at least, in some of these huge caverns, and they must have come, too, with benevolent intentions, for they have left valuable deposits of guano, which have been worked intermittently for the last 25 years. As early as 1856, perhaps even earlier, it was noticed that the brown deposit in some of the caves would burn, and during the civil war, saltpeter was made from the material by leaching and subsequent evaporation. A part of the niter thus made was used in the manufacture of gunpowder, and the bats contributed their share toward the strife that raged from the Potomac to the Rio Grande. Even these harmless, timid creatures were brought into service in those dreadful days, for men were busy in searching for material wherewith to kill other men.

A. R. Roessler, in the Texas Almanac for 1871-73, mentions a cave in Blanco County which was set on fire by a bear hunter in the endeavor to smoke out a bear that had taken refuge in it. He says that a great explosion took place and that the cave burned for two years. It is not stated what became of the bear or the hunter. In some other localities I have myself seen great piles of ashes resulting from the burning of the bat guano, and these ashes have been used locally as a fertilizer, as they carry phosphate of lime and potash. The bat caves are distributed along a line stretching in a southwest direction from Lampasas County to Uvalde and Edwards counties, a distance of some 250 miles, and have been found in the following counties, to wit: Lampasas,

Burnet, Llano, Mason, Williamson, Blanco, Gillespie, Hays, Comal, Kerr, Medina, Uvalde, and Edwards. There are limestone caves also in San Saba, Travis, and Bandera, and perhaps a little guano may be in them, but commercially they do not seem to be of much importance. Shipments of bat guano have been made along the line of the Gulf, Colorado & Santa Fe Ry., the Austin & Northwestern Ry., and the Southern Pacific Ry. It is difficult, at this time, to say just how much bat

guano has been mined and shipped from these caves. The business has been distributed over a number of years, and has not at any time been large, owing to the remoteness of the caves from the points of demand. Perhaps not more than 10,000 tons has ever been shipped, if indeed the amount be so large. The persons at present interested in the matter are John Marbach, Bracken, Comal County; Maxwell &

Thaxton, Austin; and N. J. Badu, Llano, Llano County. The composition of the material varies quite a good deal, as might be expected. The ammonia runs from 4 per cent. to 12 per cent., the available phosphoric acid may go to nearly 4 per cent., and the potash to 1.25 per cent. Some of the material

is very dry, light, and fluffy, but when it is comparatively fresh or comes from remote points in the caves, or from places more or less damp, it may carry considerable moisture. From investigations made by the writer, it was found that the weight of a cubic foot of air-dried material varied from 40 to 45 pounds, and that it would be safe to take 40 cubic feet as equivalent to 1 ton of 2,000 pounds. How great the accumulation has been in some of the caves may be known from the fact that 1,000 tons, or 40,000 cubic feet, have been taken from one cave by Mr. N. J. Badu, and that there are caves in which at least the same amount, perhaps more, is now lying unutilized. It would require quite a number of bats working overtime through many years, to accumulate 1,000 tons of dry guano.

The value of the material depends almost entirely upon the analysis. An analysis is given in Bulletin 51 of the Texas Agricultural Experiment Station, Bryan, being made by Prof. P. S. Tilson. In this the ammonia is given at 9.44 per cent., the available phosphoric acid at 3.17 per cent., and the potash at 1.32 per cent. Taking the nitrogen (7.8 per cent.) at 12 cents, the phosphoric acid at 7 cents, and the potash at 5 cents, the value of this material would be \$24.47 per ton of 2,000 pounds. No such price as this, however, could be secured now, and if this kind of guano should bring \$12 at the railroad the owner would do well to dispose of it. In 500-ton lots as much as \$22.50 has been offered for bat guano, Charleston, S. C., delivery, with 12.75 per cent. of ammonia, 4 per cent. of available phosphoric acid, and 1.50 per cent. of potash, but this was five years ago. At that time the approximate cost of getting the stuff to Charleston was as follows:

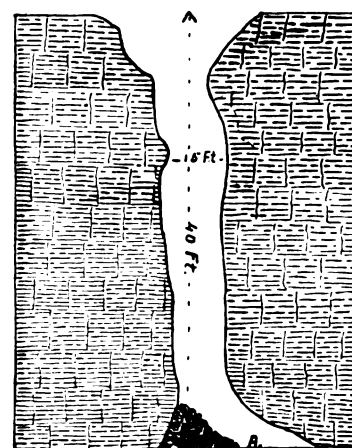
	Per Ton, 2,000 lb.
Royalty	\$ 1.00
Sacks	1.75
Mining	1.50
Freighting to railroad, 20 miles	4.50
Freight to Charleston, all rail	8.20
	\$16.95

The present price of bat guano that will carry from 8 to 10 per cent. of ammonia ranges from \$11 to \$13 a ton at railroad points along the Southern Pacific in Medina and Uvalde counties. For some time past most of it has been going to California points, although shipments have been made to Eastern points and also to Europe.

An analysis of bat guano, made by Dr. Seth M. Morris Galveston, was given to me by Mr. Badu. It is as follows:

	Per Cent.
Phosphoric acid	0.59
Sulphuric acid	1.48
Nitrogen	10.48
Non-nitrogenous }	50.00
Organic matter }	12.47
Ash	

This would represent a material with 12.67 per cent. of ammonia, and is probably the best that could be had. As before remarked, the composition of bat guano varies within considerable limits, and frequent analyses are required when one is mining and sacking. This variation is due not only to the age of the guano and whether it is wet or dry, but also to the admixture of foreign substances in it, such as clayey matters from the floor of the cave, fragments of limestone from the roof and floor, etc.

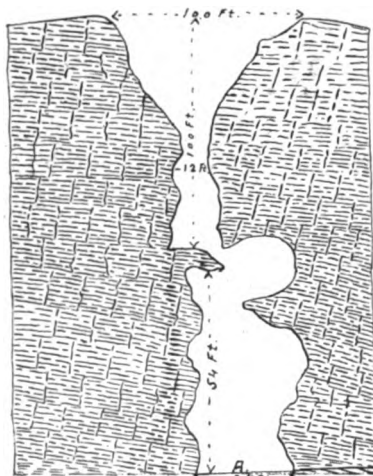


Vertical Section.



Ground Plan.

Fig. 2.



Vertical Section.



Ground Plan Donaho Cave.

Fig. 1.

Perhaps a comparison of bat guano with some other kinds of fertilizing materials may not be out of place in order that one may judge between them. For this purpose we will take analyses of Peruvian guano, bone meal, tankage, barn-yard manure, and stock-yard manure, all of them from the before-mentioned Bulletin of the Texas Agricultural Experiment Station.

	Ammonia. Per Cent.	Phosphoric Acid. Per Cent.	Potash. Per Cent.
Bat guano.....	9.44	3.17	1.32
Peruvian guano.....	10.59	14.00	2.00
Bone meal.....	4.11	25.60	
Tankage.....	14.44	5.02	0.47
Barn-yard manure.....	1.43	0.16	0.96
Stock-yard manure.....	2.18	0.58	0.84

In respect to the stock-yard manure it is to be noticed that the cattle were fed on cottonseed meal and hulls. The amount of moisture was not given, but it is to be assumed that the analyses were calculated on the same amount of this ingredient.

Bat guano is essentially an ammoniate, and should be sold as such, with additional items for the available phosphoric acid and potash. Its remoteness from market and the comparatively small quantity prevent it from competing seriously with other ammoniates. It has, however, been mined and sold at a good profit, and there is no reason why the remaining quantities should not meet with profitable sale, provided that the cheapest methods of mining and handling are adopted. A good deal of it will have to be dried before it is hauled to the railroad, over distances varying from 16 to 25 miles. One of the largest caves is in Edwards County, more than 50 miles from rail. In texture the guano varies from a softish mass, into which one sinks readily and disgustingly, to a brown, dry material that can hardly be compressed into a ball in the hand. Now and then it appears somewhat moldy, and this may be due to its being very old. In the caves I have visited, containing possibly as much as 1,200 tons in all, the material was quite dry until I approached nearer and nearer the recent deposits. Then it became soft and I mired in it above the knees. As I was quite alone, and as the light decided to go out just then, I followed its example.

During the winter the bats remain in the caves, going as far back as possible and hibernating there. When they are disturbed, they begin to twitter, a few fly by, as if on watch, and then the mass begins to stir. At first there is a muffled sound coming out of the profound blackness, but this soon gives place to a roar as of many waters, and presently innumerable soft wings and velvety forms brush past, the advance guard. The roar increases, the foul air sweeps by in waves of fetidness, and the main body is on the wing. By the dimmed light one may see shadowy forms hurrying past, thousands and thousands, until the vast caverns seem to throb with the motion. Curiosity may keep one for a while in the midst of these myriads of frightened creatures, but it is the part of wisdom to retire to a more salubrious spot. If the weather is somewhat chilly the bats do not leave the cave, but circle around and around until one becomes dizzy in watching the interminable circlings. In the spring and summer the bats leave the cave in the late afternoon and return early next morning. From one orifice, which is 12 feet in diameter, they have been observed to emerge for three hours, rising 100 feet into the air as a great circling column of black smoke before they begin to separate. They pour out from the opening as smoke from a chimney, and are as the sands by the seashore for multitude.

Perhaps a description of two of the larger caves visited, together with a few sketches and photographs, on the surface and

underground, will serve to illustrate the subject sufficiently for our present purpose. It is difficult to secure flash-light photographs in these huge caverns owing to the practical impossibility of illuminating them. Some flash-light pictures, however, were obtained by use of Blitz-Pulver in the rooms of lesser size and in a few of the narrow passages. One of the caves visited is in the northwestern part of Medina County near the Uvalde County line on land belonging to Mrs. Donaho. It is about 2 miles beyond the Jacob Reinhart ranch and near Secos Creek. The surrounding country is undulating, and within a mile of the cave the hills rise to a height of several hundred feet. There is a good road from Hondo, 23 miles, and from D'Hannis, 16 miles, stations on the Southern Pacific Railway. The opening into the cave is on a slight rise about 30 feet above Secos Creek 200 yards from it. A huge funnel-shaped depression, 100 feet in diameter at the surface, leads down into the cave proper. The first bench is at a depth of 100 feet from the rim of the funnel, the floor then slopes 6 feet in 25 feet and at this point there is another vertical descent for 54 feet making the total depth from the rim of the funnel to the permanent floor 160 feet. Fig. 1 gives a vertical section from the rim of the funnel to the permanent floor, and shows an offset 22 feet from the projection extending over the last descent.

The general shape of the shaft, hewn out of limestone by the action of water and air, is that of an enormous funnel set in the mouth of a bottle of very irregular shape. At its narrowest part, the neck of the bottle, the diameter is 12 feet, and so numerous are the bats in this cave that it requires three hours for them to emerge through it. One of my companions, who attempted to enumerate the number of bats, finally gave it up and threw his paper and pencil down, saying his arithmetic had "gin out." The cave has been entered by several different persons, but no guano has ever been removed from it, and it is now leased by Messrs. Maxwell & Thaxton, Austin, who propose to work it, hauling the material to D'Hannis, 16 miles, and shipping over the Southern Pacific Railway.

The cave is now difficult of access. The only means of getting down into it is by rope, and when one swings clear of the projecting ledges and begins to spin around like a top, with the blue sky above and the brown rocks beneath, he realizes the uncertainty of life. I made two trips down, first on a rope, to see what arrangements could be made for a comfortable descent, and then on a ladder, which we constructed of $\frac{3}{4}$ -inch manila rope and mesquit rungs. A great poet has said that a certain descent was easy but the return trip was laborious. He referred to an unmentionable place but might have had this cave in his mind. On the first trip I spun around at the end of the rope until I was glad to land even upon a skunk whose defunct body was in perfect harmony with his malodorous life. It was a large place into which he had fallen, but he filled it completely and could have filled several acres. There was another one 60 feet lower, and together they made a pair hard to beat. What they left to be desired in the way of odor was more than supplied by the bats.

Fig. 1 also gives a plan of the bottom of the cave where the guano is found and where the bats most do congregate.

It is difficult to estimate the amount of guano in a place such as this. The floor is of irregular shape, and many large fragments of stone that have dropped from the roof are to be met with, besides smaller pieces that have become imbedded in the mass. What appears to be a bed of guano of considerable thickness is found, on investigation, to be a layer of from 1 to 6 inches in thickness covering the rock. A few feet from this point the

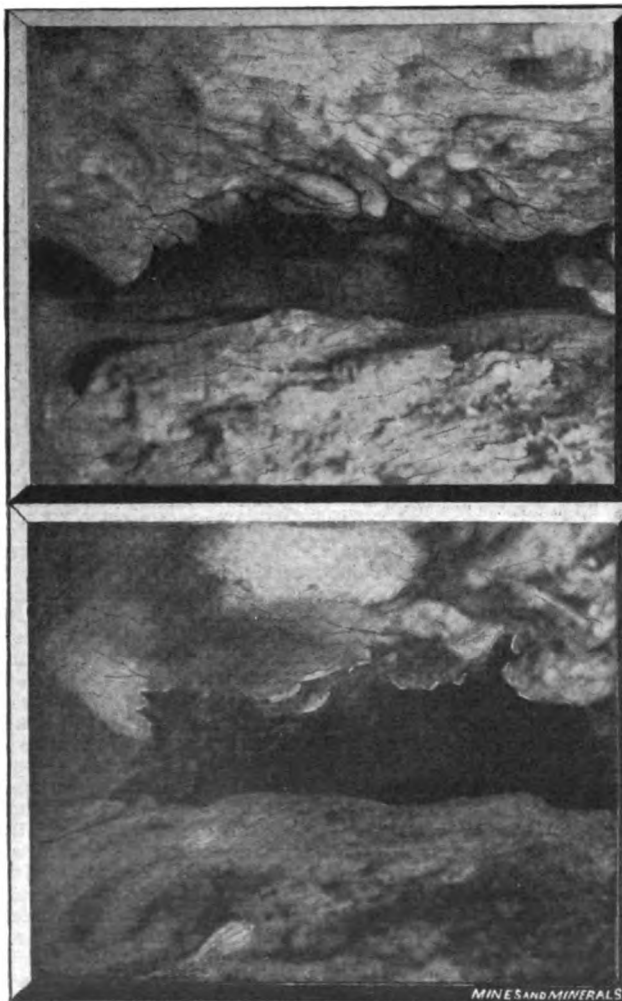


FIG. 3. PHOTOGRAPHS IN TUNNEL, BAT GUANO CAVE.

guano may be 4 or 5 feet deep, completely filling the depressions in the floor. In some places it is banked up in mounds, or spread out evenly on the floor, where it is comparatively level. One can walk for 1,000 feet without stepping off from the guano, and can wade in it up to his knees. Most of the material in this cave is dry, but towards the northeast end it becomes soft and is evidently of more recent origin. When the bats become tired of one roosting place they go to another. Some of the smaller chambers opening out from the main cavern do not seem to have been used by the bats at all, for there is no guano in them nor any indication that they were ever used by the bats. It is said that the bats sometimes become tired of a certain cave and desert it entirely, taking up their abode in some adjoining cavern. The odor at times may prove too strong even for a bat, and he moves to cleaner quarters. Another bat guano cave that I will briefly describe is on the Cook Survey in the northwestern part of Burnet County, 23 miles from the town of Burnet, and about the same distance from Lampasas. It is of much larger extent than the Donaho Cave, contains a great deal more guano, and is far easier of access, as one has only a short climb down the sides to a 10-foot ladder. It is in Silurian limestone, probably Trenton, and is on the ridge to the northwest of Beaver Creek. Here also the opening is funnel-shaped, but only about 50 feet in diameter.

Fig. 2 gives a vertical section down to the floor, and also a plan of the interior so far as we went. There were so many bats in the east chamber, the air so foul, and the heat so oppressive that we did not go to the end. So far as known, no one has been to the extremity of the east chamber, and it may lead back to a considerable distance. At some time or other there has been a fire in the northwest chamber, and the ashes of the guano cover portions of the floor to a depth of 2 and 3 feet. The bats deserted this chamber and took up their lodgings in the east chamber, where they are now. Several attempts were made to secure flash-light photographs of the mounds of guano in the east chamber, but we were not able to obtain sufficient illumination. We had, therefore, to content ourselves with photographing such parts of the smaller chambers as could be illuminated with Blitz-Pulver. If one could ignite several large portions of the powder synchronously and within a restricted area he might be able to photograph one of the larger chambers. The best result we secured was in photographing a mound of guano that had banked up against the limestone walls. This mound is 10 feet high. Smaller chambers open out from the main east chamber at intervals along its entire length.

Fig. 3 shows the difficulties attending the exploration of some of these caves. The photographs were taken lying at full length in a tunnel that was less than 2 feet in the clear and the top was liberally supplied with sharp stalactites that continually admonished us to "lie low." Into such very narrow places the bats seldom go—only a man has so little sense.

Not all of the caves are entered by vertical descent; some of them are clefts in the rock and can be worked as a drift is worked.

But few dimensions have been given in these sketches and for the reason that the caverns and underground chambers vary in width and height to a remarkable degree. They are of most irregular dimensions, contracting here, bulging out there, rising to a height of 30 and 40 feet and sinking to low passages. Some of the larger caves are not inhabited by the bats, and in a few of them the growths of stalactite and stalagmite are beautiful. One of these caves, the Sherrill Cave, 8 miles south of west of Burnet, has been penetrated for 3 miles, but no bats have been found in it. It is not likely that the bat guano business has ever assumed any considerable proportions and there is nothing now to indicate that it will become more important. The material remaining in some of the caves could be worked profitably and doubtless will be used. Two of the caves sold for \$3,000, the purchaser removing the guano himself, and a third interest in another cave brought \$2,000. Some are leased at so much a ton taken out, others on a percentage of the net profits, while others have been purchased outright. So far as known the bat caves in Mexico have not been worked, and but little information is available concerning them.

The State of Texas uses but little commercial fertilizer, for the soils are naturally of great fertility and need only rain to make them produce abundantly.

The bat caves of New Mexico, situated in the southern part of the Territory, are being worked extensively by Mr. John R. DeMier, Lava, New Mexico. He has already shipped 140 carloads of high-grade material, some of it containing 18½ per cent. of ammonia. He has also a material containing 32 per cent. of phosphoric acid; with 28 per cent. available; 16 per cent. of potash; with 9 per cent. soluble in water; and 2 to 4 per cent. of ammonia.

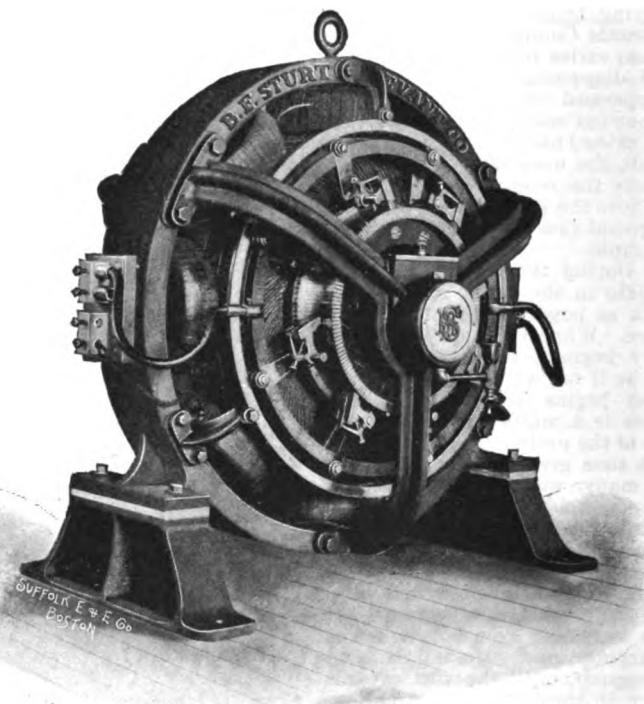
The Sturtevant 8-Pole Motor.

The 8-pole type of motor lends itself particularly well to adoption for fan driving. Its comparative lightness and its compactness make it a comparatively simple matter to attach it to the side of the ordinary fan. The B. F. Sturtevant Co., of Boston, Mass., has been developing the electric fan along various lines during the past few years, and as an outcome has produced a type of 8-pole motor, illustrated herewith, which may be either attached directly to the fan side, or, as shown, supported upon feet and used as an independent machine.

The field ring, which also constitutes the frame is of wrought iron in the small, of cast steel in the medium, and of cast iron in the large size. The field cores are of wrought iron and the pole shoes of cast iron, of such peculiar shape and size as to render these machines capable of meeting extreme variations of load without sparking or the necessity of adjustment.

The field coils are machine wound, thoroughly insulated, and of such open construction as to secure the maximum radiation and ventilation. The armature core is built up of laminated slotted disks, which are solidly clamped between two brass rings having corresponding slots. The coils are machine wound, of uniform size and shape, and thoroughly insulated, the armature being of the drum type.

The commutator is of large diameter, the segments being of



fine drop-forged copper. For high voltages or small outputs at low speeds two sets of reaction carbon brushes are usually employed, and from the character of the design require no adjustment. Tripod bearing yokes are provided as shown, except in the largest machines, which are equipped with special bases and pedestal bearings. The shaft runs in gun-metal sleeves and is lubricated by means of ring oilers.

In this style these motors are built in powers ranging from 3 to 37½ H. P. at normal speed. In larger sizes a pedestal base is provided giving the motor a still more substantial character. In all sizes these machines are built both as motors and generators.

Before a recent meeting of the South Wales Institute of Engineers, Mr. W. S. Gresley, of Erie, Pa., suggested the continuous hoisting of coal to replace the present method of hoisting by cages and hoisting engines. Mr. Gresley proposes a system similar to the old-fashioned man engine, by which the cars should be placed upon a single or double decked platform, hoisted a certain distance and then by automatic machinery transferred to another double platform which would for a moment be at the same level as the platform first mentioned. This would give a slow moving, continuous output. No details of the necessary machinery were presented, but simply a suggestion that such an apparatus might be devised which would prove advantageous.

TUNNELS AND TUNNEL SCHEMES.

The Adit and the Crosscut, Their Advantages and Disadvantages—Circumstances Where the Driving of Each Is Advisable.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

There are various kinds of tunnels and various motives for constructing them. The two classes we have at present in view are long "adit" tunnels and long "crosscut" tunnels, principally the latter.

An adit tunnel is a tunnel driven directly in on a vein following its course or strike. It is a genuine mining and development tunnel and usually develops and gets out its ore as it goes along like any other legitimate mining excavation.

The long crosscut tunnel is not driven along the course of a vein but through more or less barren zones of country rock to cut at an angle and at great depth veins known to exist on the surface and partially developed and proven there, and to search for other veins, called "blind veins," of whose existence there is no certain knowledge and whose outcrop for various reasons does not appear on the surface. So the long crosscut tunnel is in part a prospecting and exploring tunnel, in that it goes in search of unknown but probably existing veins, as well as well-known and partially developed ones.

An adit tunnel is usually driven as low down on the course of a vein as the position of the vein on the side of mountain will admit, commonly at the very base of the mountain, or close to the valley; the object being to gain depth under the mountain and facilities for transportation by wagon or railroad; also nearness to water for a mill at the adit's mouth to concentrate the ores direct from the mine without further handling by wagon. From this tunnel at the base, stopes, winzes, and shafts, may connect with the upper surface of the mountain, or with other tunnels driven at higher levels along the course of the same vein.

Development by adit tunnels is a favorite one because of its cheapness, its advantages for easy extraction and transportation of ore, and for overcoming that formidable element in most deep mines, viz., water, by an easy system of natural gravity drainage. The whole haulage system of the mine also becomes one by gravity alone, or of easy mule haulage.

"Sinking," as it is called, or shafting down on a vein costs much more than tunneling; every foot excavated has to be timbered up carefully, every pound of ore and every ton of waste rock, as well as every gallon of water, has to be raised to the surface. This involves a hoisting plant, steam, coal, and an engineer in charge.

In tunneling, often as soon as cover is attained, or after the first 50 or 100 feet, the rock may be so compact that no timbering of any kind is required. This is particularly the case in long crosscuts in such rocks as granite for example. Adit tunnels on the vein, owing to the softness of the vein, may require timbering partially or throughout. In the crosscut, timber is only likely to be needed when a vein is cut, and then only for a very short distance in the tunnel itself. So when possible the adit tunnel system is preferred to all others, so long as the slope of the hill and nature of the ground will admit.

When great depth has been attained in a mine far below the valley level, the tunnels or drifts, of course, never come to the surface, but are connected with the surface workings by a shaft or upraise. An upraise to the surface could be made from below the valley level, but usually this is avoided, owing to the accumulation of water likely to be met with in such a situation. From these

lower tunnels, water, ore, and rock all have to be hoisted to the surface through a main connecting shaft. So you may see mines, like some at Rossland, B. C., which were opened originally by adit tunnels in the upper part of the mountain, but when the valley was reached, had to be continued downwards by a shaft with drifts extending from it on either side following the course of the vein.

There are certain regions and districts particularly adapted to the adit, or crosscut tunnel system, where at times such a system is an absolute necessity, and there are other districts which are unfavorable and offer no natural advantages.

The favorable regions are those characterized by high mountains with precipitous sides and deep cañons. Such regions, for example, are the San Juan and Clear Creek districts of Colorado. In these regions, notably in the San Juan, a series of big strong fissure veins may be seen outcropping in bold walls on the summit of a mountain 2,000 feet above the stream and cañon below; the veins descend the side of one mountain like great yellow or red ribbons and ascend the opposite one. Such veins are typical ones for the adit system. Depth under the mountain and on the vein is rapidly gained.

When the slope of a mountain is very gentle or gradual it is obvious that it will take a long adit tunnel to gain any great amount of depth. The advantage of depth from below upwards, we may here observe, is that it is so much easier to develop and stoop from below upwards than to dig down from above and develop downwards. The former is a simple natural gravity system, the latter demands hoisting and machinery.

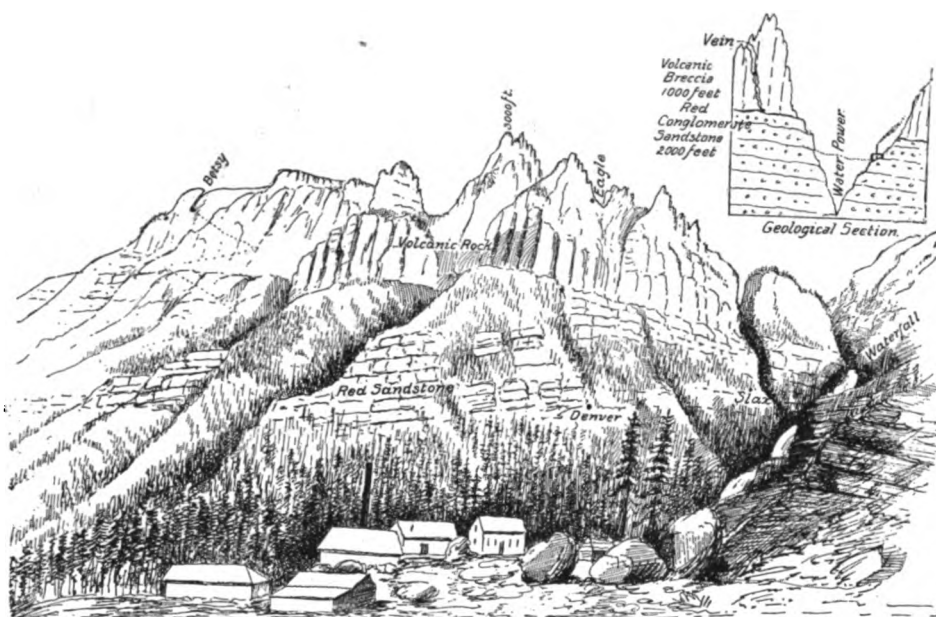
There are some regions, as we have observed, that are not so well adapted to the adit or crosscut tunnel system, or if a tunnel be made, it will have to be a very long one to attain the depth required and the object for which it was driven.

Take Leadville, Colorado, where the higher portion of the Leadville region in the Mosquito Range is accessible to the tunnel system. A portion of the hills occupied by the mines is, however, low comparatively, and has long gentle slopes, and many of the mines have attained a depth

far below that of the intersecting ravines below them. A good location has, however, in one place been selected for the noted Yak crosscut tunnel which has had to go through a long distance, mostly in barren granite, before it reached the zone of easterly dipping limestones and porphyries in which both the Leadville gold and silver belts are located. It was projected for a distance of 3 miles and probably later will far exceed that.

It would be a much desired thing to have a long crosscut tunnel driven in from the Arkansas Valley to tap and relieve the overwhelming drainage of the so-called "Down Town" mines of Leadville, but in this case the nature of the ground is so flat, or so gently sloping for miles down to the Arkansas River that a long tunnel would hardly gain a greater depth than 400 feet, and nearly all the Down Town mines of importance are deeper than that, or would be long before such a tunnel could reach them. It is something like the case of the celebrated Sutro Tunnel on the Comstock lode, which was projected to unwater and transport from that celebrated vein, but by the time the great tunnel had reached its appointed goal the principal shafts had gone down far below the tunnel level.

Central City, Colorado, is a district not specially favorable for deep adit, or drainage crosscut tunnels, because it is, so to speak, on top of the mountains, and the district is not dissected by any very deep cañon contiguous to the mines, from which an important drainage tunnel commanding a great depth could be located, many of the mines there having exceeded the 1,000-foot level and a few the 2,000-foot. Hence the great Newhouse Tunnel



SAN JUAN REGION—VEINS PRODUCTIVE IN VOLCANIC DIORITE BUT NOT SO IN RED SANDSTONE.

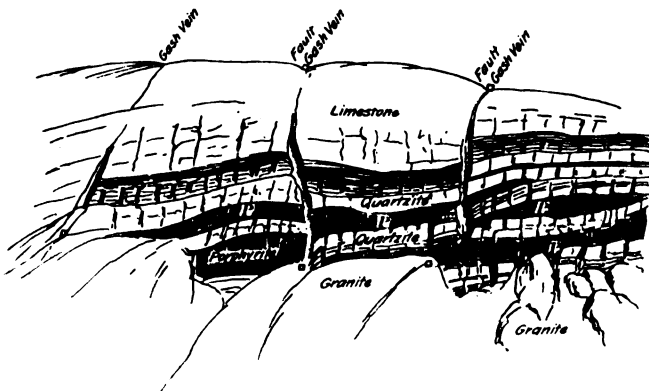
from Idaho Springs had to be projected, a big wide tunnel, started from Idaho Springs, in South Clear Creek Cañon 4 miles due south of Central City, and which at that length would tap, or go below, the deepest mine of the Central City region at a vertical distance from the surface of between 2,000 and 3,000 feet.

Idaho Springs, in South Clear Creek Cañon, is a good location for tunnels, both adit and crosscut. The steepness of the mountains above the creek admits of gaining great depth in a very short horizontal distance, and the hills are full of veins, both developed and undeveloped. Hence there are numerous tunnel schemes on foot in the neighborhood. As typical of an adit tunnel combined with a crosscut scheme, we might mention the Knickerbocker Tunnel driven on a wide well-defined vein of low-grade ore and cutting in its projected course a number of cross-veins, whose values have been proven by working on the surface, and undercutting, finally, the once celebrated Crown Point Virginia Mine on the same vein and relieving it of water, as well as receiving and transporting its ores. Its projected length is 3,000 feet, of which it has passed 1,000.

The Lamartine Tunnel in the same neighborhood is in part an adit and in part a crosscut tunnel 2 miles in length. It was a tunnel of necessity, necessitated by the overwhelming amount of water encountered in the lower workings, which threatened to cause the permanent closing down of this productive mine. Now the mine is free from water, and ore, waste rock, and water all pass out of the tunnel by an easy natural gravity system.

Georgetown, in the same Clear Creek district, is also a good locality for the tunnel scheme. Its mountains rise abruptly above the creek for over 2,000 feet. Most of the old and once highly productive silver mines are located near the summit of these mountains. Few of these mines are over 500 feet in depth, several have been abandoned, not for lack of ore or its value, for the silver values are some of the highest in Colorado, but because after the fall in silver they were worked by poor men, mostly leasers, and they could not erect hoisting works, or pumps of sufficient capacity to control the overwhelming water, nor had they capital enough to drive long crosscut tunnels at sufficient depth to permanently relieve their excessive drainage. To their rescue, like the Newhouse Tunnel to the water-burdened mines of Central, is projected the Kelly Tunnel, located like the Newhouse near the bed of Clear Creek, at the base of Democrat Mountain, which it pierces, in a course of 2 miles through solid granite, at a depth of between 1,000 and 2,000 feet from the surface. Some forty of the best known veins of the district will be cut, together with many at present unknown, and many of the old and valuable mines will be drained and resume work. An account of this undertaking we hope to give at another time.

There are sometimes districts of which heretofore but little has been known and developments have not been very great, but where numerous undeveloped veins come to the surface. Such are tempting subjects for experimental long crosscut tunnels to show up what these regions may or may not contain. It has all the charm, romance, and risk of a prospecting scheme. Of such a nature is the Empire Tunnel near Empire City projected to cut through Covode Mountain at considerable depth, with the advantage of a fine water power at the tunnel's mouth for treating the low-grade ore likely to be encountered.

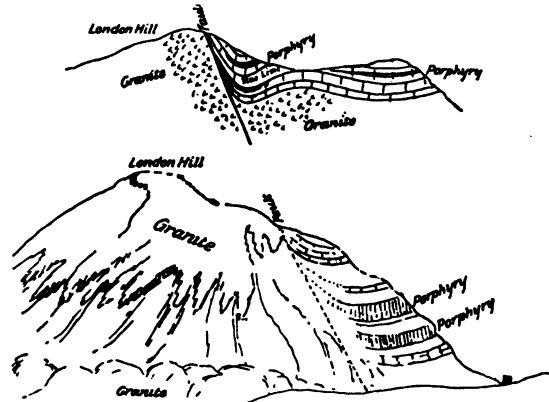


SILVER-LEAD GASH VEINS IN FAULTS.

Cripple Creek is a subject for the long tunnel scheme with advantages and disadvantages. Although the rounded hills of volcanic rock attain a fair altitude, the region is not intersected by many deep cañons from which tunnels could be driven attaining very great depth. Hence tunnel schemes here must generally be long ones and be of the crosscut exploring kind. Some mines met along the course of a tunnel are likely to have shafts going below the tunnel level. One or two tunnels have already been

carried out to locally drain certain well-known mines. Another has been driven clear through the granite of Squaw Mountain to transport the ores of the Gold Coin Mine to its mill on the opposite side in Arequa Gulch. This tunnel encountered in its course singularly few known or hitherto unknown veins in the Squaw Mountain granite.

Another tunnel was projected to go clear through the Cripple Creek district and undercut it at considerable depth from West to



THE LONDON MINE FAULT.

East. The progress of this tunnel, after a thousand feet or more, was interrupted unexpectedly by striking an enormous body of water which broke in with such violence that one of the two men at work was drowned, and another narrowly escaped sharing the same fate, whilst for many days such a volume of water poured from the outlet of the tunnel that hundreds of people from the city came to view the novel sight, particularly novel in Cripple Creek, where in early days the mines were remarkably dry and there was not enough water to run the machinery. Since then most of the mines with depth have encountered more water than they needed and powerful pumps have had to be put in to control it. The earliest instances of striking water in this region were in two mines, from one of which a stream has since continuously flowed, sufficient at one time to run a large mill located in the gulch. So there may be unexpected difficulties encountered in putting through a tunnel scheme.

Many of the big tunnel schemes in Colorado that have been carried out to a successful completion have been from *afterthought* rather than from *forethought*. Their inception has arisen rather from sheer necessity of the case than from an enterprise entered in or upon as a possibly profitable speculation. They have been entered in on, too, in the later, rather than in the earlier, stages of a mine. In most cases they have been driven by the compulsion of water, which at the depth the mine had attained, after years of work and development, threatened to drown the mine out or close it down. The expense of a long tunnel, usually a crosscut, to underdrain the mine was the final outcome, combining with the relief of drainage a very desirable method of gravity transportation. Of such a nature was the Cowenhoven Tunnel in the Smuggler Mine at Aspen and the Lamartine Tunnel, already mentioned, near Idaho Springs. These were driven in a very different spirit from those undertaken by some men, who after finding some ore in a vein say a thousand feet above the valley, persuade their company to run a long crosscut through barren country rock to cut the same vein at greater depth before their mine is developed or before they know what they have got. Such crosscuts somehow generally turn out much longer than was anticipated, they generally prove "long" cuts rather than "short" cuts to fortune. Not infrequently the vein has been actually met and cut, but not being recognized as the true vein from its seeming insignificance, the tunnel has gone blindly on into the hill till the patience and funds of the stockholders were exhausted.

The veins appearing large and well on the surface may not necessarily prove so at very great depths, though in many cases they may prove even better and richer than near the surface.

In a granite region like that of Clear Creek County experience causes us to place considerable confidence in these fissure veins continuing down with depth in undiminished size, strength, and values. Some of them have proven so at a depth of 2,000 feet and lately the Gem vein cut at more than that depth, and 2 miles within the heart of the mountain, by the Newhouse Tunnel has proven both richer and wider than its developments show near the surface. A region characterized by great persistent veins is a fit subject for a long crosscut tunnel.

But there are some regions upon which less reliability upon depth can be placed than others. This is notably the case in

regions characterized by marked and sudden changes in the rock formations such as where fissure veins occur in a thick sheet of eruptive rock overlying beds of sedimentary origin. The so-called fissure veins may be quite productive as they continue in the volcanic rock, but the fissures may abruptly cease at contact with the underlying sedimentaries, or if continued downward become a mere unprofitable veinstone. We have seen such cases in the La Plata Mountains, where veins were productive of telluride ores in a thick overlying mass of eruptive diorite rock, but ceased to be so in the underlying Cretaceous or Triassic sedimentary rock. The owner of the mines in the diorite hill above, persuaded his company that a long crosscut tunnel in the valley below through the underlying red Triassic rocks would be the best means of drainage and development of the mines and transportation of ore to their mill in the valley below. A long crosscut tunnel accordingly was driven at the valley level through the red sandstone. The vein was indeed cut but in the red sandstone proved mere barren quartz and gypsum. After following this for some distance laterally, the owner concluded that it could not be the original vein so productive in the diorite a thousand feet above and went marching on with the tunnel till funds in the East cried halt!

Another condition may be where sedimentary rocks are interbedded with intrusive sheets of porphyry and the whole series reposes on underlying granite. This series may be traversed by a series of parallel vertical fissures corresponding to a system of jointage or small fault-fissures, and in places these fissures may be productive, but they are usually of the nature of "gash" veins rather than true fissures, and will not, as a rule, be found continuing down into the granite, or if so continued, they may cease to be productive and be only unprofitable veinstone. Such cases often occur in the Mosquito Range of South Park. Such a section would be a dangerous one for a long crosscut tunnel undertaking.

At the London mine at South Park a body of Paleozoic sedimentary rocks reposing on granite beneath is violently folded up and tilted back to verticality against a profound fault in an adjacent granite mountain. This violent action has opened the leaves of the tilted strata and they have slid back upon one another producing seemingly vertical fissures more or less filled with ore and with all the approved true fissure signs, such as slickenside walls, gouge, and even quartz and ore filling. It was not unnaturally supposed, from their verticality and other "true fissure" signs, that these were deep seated fissures paralleling the great fissure of the adjacent London fault, and on this hypothesis a long crosscut tunnel was contemplated through the granite that would tap these "fissure veins" deep down in the granite, drain them, and by a gravity system bring the ores to the mill and to a convenient dumpage ground in the valley below. According to our opinion these slip or sliding fissures were confined to the sedimentary strata and did not go down into the granite at all, hence such a long deep-seated crosscut tunnel in the granite would on arriving at its destination find no vein or fissure (except the great London fault-fissure) and have to make a lofty upraise into the overlying sedimentary beds to recover the veins.

Long crosscut tunnels are expensive undertakings, and it is advisable to consider well such undertakings before beginning. Many a one have we observed that has proved a complete failure from want of knowledge of the geological relations of the ground. An experienced, conservative mining man is generally very careful how he embarks on such a scheme, though whilst many have been failures many have also proven successes.

The big legitimate exploring crosscut tunnel schemes are usually enterprises undertaken by those of a bold speculative turn rather than by the average more conservative and experienced mining man. They have their place, however, and an important one in the mining field, and are important factors in opening up a camp on a liberal scale. Wonderful feats have been performed in past and early times in this line, considering the lack of all the new improvements in machinery, excavating tools, and explosives, that we have now, which reduce such enterprises to a minimum of expense and to the shortest possible time for completion.

A big crosscut exploring tunnel is a scheme that demands lots of capital back of it to make it a success and to make it go through. There must be nothing "cheap and nasty" about it nor any "Mr. Ready-to-halts" amongst the projectors. Many of these big tunnel schemes are likely to be a success if they are pushed through to their completion, but if they stop short of this, by lack of funds or by the shareholders losing patience, failure is inevitable. They are enterprises, also, that whilst interesting and with something of the gambling excitement in them may require a good deal of patience.

Ideally, a long tunnel should not begin developing on the veins it may have cut until the whole tunnel is completed, as the work on veins may somewhat interfere with the work on the tunnel, but it would be a sore trial of the patience of share-

holders to wait some 3 or 4 years till a tunnel perhaps 2 miles in length is completed before developing on any of the good veins the tunnel has cut. In point of fact, development on veins is sure to be done to a certain extent before the final consummation of the tunnel is reached. Thus the Newhouse Tunnel after several years of patient work, and after penetrating over a mile into the mountain, has at last struck the first of the many important veins and ore bodies it is likely to meet with in its course. Large bins have been erected near the huge dump that has accumulated at the entrance of the tunnel for receiving and storing the ore that is being developed on the vein.

This doubtless greatly encourages the shareholders, and they look forward with fresh vim to the two or three miles more ahead of them, which is known to be the veiniest part of the whole region.

CURRENT MINING DECISIONS.

Specific Performance of Coal Lease Decried by Court.—A valid agreement, definite, and fair, and reasonable in its terms, was made for the lease of a tract of coal land, to be mined by lessee. The lease would necessarily extend through a number of years. The quantity to be mined each year was uncertain, and payment of royalty was to be made according to a sliding scale, varying from year to year. Owing to a known fault in the vein, but the extent of which was unknown, the total quantity of coal to be mined was very largely a matter of uncertainty. The court held that specific performance of the agreement would be decreed at suit of the lessor, on the ground of the inadequacy of his remedy at law for non-performance, arising from the impossibility of determining the amount of his damages with any reasonable degree of accuracy.—*Oakford v. Hackley*, 92 Federal Reporter, 38. (Circuit Court of U. S.)

Freight Lien Not Lost by Delivery on "Spur" Track.—On an issue as to whether a carrier, by delivery to the consignee, had lost his lien for freight, it appeared that carloads of coal on which the lien was claimed were, on reaching their destination, placed on spur tracks on the premises of the consignee; he had furnished the ties, while the railroad company had built the tracks and furnished the iron. The spur tracks were operated exclusively by the railroad company, and part of its charge was for placing the coal on the spur track. Before the consignee could handle the coal, it was necessary to remove the cars from the spur track, and move them along the main track, thence along a branch track on the premises of the consignee to his docks, and this was done by the crew of the railroad company, and its engines were used, these being furnished by the superintendent of the railroad on request. The court held that placing the cars on the spur tracks was not a delivery of the coal, so as to deprive the railroad company of its lien for freight.—*N. Y. Cent. & H. R. R. Co. v. Davis*, 52 Northeastern Reporter, 1,125. (Court of Appeals of New York.)

What Constitutes an "Incompetent Hoisting Engineer."—A hoisting engineer in a coal mine, and a miner employed in such mine are fellow servants, and the common employer cannot be held liable for the negligent management of the engine by such engineer, unless he is incompetent, and the employer is guilty of negligence in retaining him after notice of such incompetency. While the technical knowledge and physical ability of a hoisting engineer may be sufficient to stand the test of an examination, under state laws, a reckless disposition may render him utterly unfit to operate the machinery placed under his control. Incompetency exists, not alone in mental and physical attributes, but also in the disposition with which a servant performs his duties. If, instead of being watchful, he becomes inattentive and habitually neglects his duties, he becomes unreliable, and, although possessing the mental and physical ability to do his work, his disposition towards the general safety of his fellow workmen renders him incompetent. And, if the employer ascertains, either by personal observation or the report of others, that the holder of a state certificate of ability to run a hoisting engine, is not, in fact, competent, and retains him in his service, he will be liable for all injuries resulting from such incompetency. Incompetency does not have to be shown by general bad reputation, but may be shown by frequent occurrences of imprudence, carelessness, or recklessness. Wherever it is sought to fasten liability upon an employer for an injury resulting from incompetency, the prior acts and conduct of such servant on specific occasions may be given in evidence with proof that the employer had notice of such acts. A certificate of a hoisting engineer obtained under a state law goes no further than to say that the bearer, at the time of issuing it had the technical knowledge and skill, coupled with the physical ability, to properly and safely run the engine, and is only prima facie evidence of such competency, which may be rebutted as indicated.—*Consolidated Coal Co. v. Seniger*, 79 App. Ct. Report, 456. (Appellate Court of Ill.)

THE ALABAMA COAL FIELDS.

Their Location and Characteristics—An Account of the Early Discoveries and Development, and the Present Output.

Written for MINES AND MINERALS, by Henry McCalley, Alabama Geological Survey.

The coal fields of Alabama are the southwest end of the great Appalachian coal field, before it either becomes covered up by newer formations or dies out on the southwest. Their lower strata, at least, were once continuous with those of the coal measures of Tennessee or the rest of the Appalachian coal field. They formed one great unbroken coal field that covered nearly the northern quarter of Alabama, or at least some 10,000 square miles within the State, prior to the Appalachian revolution, when there was pushed up across this great field a series of parallel ridges with a northeast and southwest trend. The strata of these ridges were so broken up and crushed in their upheaval that they were much more easily washed away than those of the adjacent areas and so the ridges have been washed down into the present well-known anticlinal valleys of older rocks that now divide the coal fields into three separate and distinct parts. These three parts, with a combined area of something like 8,860 square miles,

Their coals are in groups along with a series of sandstones, conglomerates, and shales, with some little limestone at several horizontal positions. The conglomerates are thickest and coarsest near the bottom and top of the measures. Fireclays, partly at least from the weathering of argillaceous shales, occur as underbeds to many of the coal seams. The coal seams of the three different fields have never been correlated, though there is no doubt about their being once connected and about there being some 50 separate and distinct coal seams in Alabama. These coal seams range in thickness from a few inches to some 16 feet, though the thicker seams are cut up more or less by slate partings.

Coal was mined or dug from the outcrops in Alabama as far back as 1836, but there is no record of any underground mining previous to 1849. During August, September, and October, 1849, there are said to have been three underground mines in operation in Alabama and about 200 men engaged in the coal trade, but there was no systematic attempt at mining and shipping Alabama coal until 1853. Most of the coal that was mined prior to the "war between the States," was taken from the beds of the rivers and mouths of the creeks, at low stages of the water during the summer months, loaded on flatboats built close at hand and floated down the rivers during freshets to market. Prof. Tuomey, in his "First Biennial Report," 1850, thus describes the novel process of mining coal by diving for it: "A flatboat is

moored parallel with the joints, and near the edge of the coal; long wedge-shaped crowbars are driven into the seams by means of mauls maneuvered by men in the boat. When a ledge of about two feet is loosened, in this way, across the seam, the men take to the water, and dive two or three together, according to the size of the masses to be brought up, and lift the coal bodily to the surface, and place it in the boat. As an improvement on this simple process, a crane is rigged on the boat, and a chain slipped around the blocks of coal raises them into the boat. I have seen, in this manner, masses raised that weighed 800 or 1,000 pounds. The coal thus raised is free from all shale and other impurities, for, as the coal parts along the bands of shale, the latter are left behind. Notwithstanding the primitive appearance of this method of raising coal, it is, nevertheless, under favorable circumstances, and where the water is not too deep, one of the cheapest modes in practice, and with the addition of a diving dress, I am inclined to think that in no way could coal be raised at an expense so moderate." The boats are said to have held some 2,000 bushels of coal, and the coal to have sold at the river markets at from 4 to 40 cents per bushel and from \$6 to \$15 per ton. The business, however, was so dangerous



ROBINSON-RAMSEY COAL WASHING AND SCREENING PLANT AND 6,000 TON COAL BIN, PRATT CITY, ALA.

are of very unequal areas. They were named by Prof. Michael Tuomey, in 1849, from the names of the rivers which drain them, the *Warrior*, *Cahaba*, and *Coosa* coal fields. The elevated rims of these coal fields, of tilted strata, gave the general directions to most of their watercourses. The separating valleys, therefore, present the unusual features of being valleys, in a mountainous country, that are water divides, being higher than the mountainous countries beyond their elevated rims.

The three coal fields are bounded on the northwest and northeast by mountainous rims, and on the southeast wholly or partly by big thrust faults, while on the southwest the two larger ones become covered up by newer formations and the smaller one ends in a high mountain. They are most elevated at their northeast ends and along their northwest edges, gradually sloping, in a general way, towards the southwest and the southeast. They have more or less distinct basin areas along their southeast edges, over their thickest strata.

They have the great advantages of being near the great deposits of iron ores and fluxes of the narrow valleys that separate them, and of having their most productive measures easily accessible to railroads and penetrated by rivers that can be made navigable for steam tugs and coal barges. They have the advantage, also, of having the nearest true coals to the Atlantic coast south of Charleston and to the Gulf of Mexico.

to life and to the boats with their cargoes in going over the shoals, that no considerable capital was ever invested in it and no regular miners ever engaged in it.

Considerable explorations were made in the Alabama coal fields in 1863 in the search for a coal that would make good coke for the manufacture of cannons and heavy ordnance at the Confederate Government foundry at Selma, Alabama, but no development of consequence was done in any of the fields for a long time afterwards because of the want of transportation facilities, and the comparatively small demand in the Southern States for coal and coke. The total production of coal in Alabama for all of the years previous to 1874 has been estimated at only 450,000 tons.

Systematic underground coal mining in Alabama, though it may date back to the fifties, did not therefore amount to much in a commercial way until late in the seventies. Since then it has grown very rapidly until now Alabama as a coal-producing State ranks fifth in the list of the States of the Union, and of the Southern States she is only surpassed by West Virginia. Her output for the calendar year 1899, as given by the State Mine Inspectors, was 7,484,000 tons of 2,000 pounds, with a spot value of over \$8,000,000, and has been estimated by them for the calendar year 1900 at 8,500,000 tons. The output for 1899 is the product of some 200 different underground mines on some 25

different seams of coal that range in thickness from about 18 inches to 9 feet. These mines are all close to present lines of transportation, and they are nearly all on the coal outcrops. Their annual outputs for 1899 varied from about 150 tons to 308,000 tons, and nearly one-half of their total output for that year was mined by one company, the Tennessee Coal, Iron, and Railroad Company.

More than half of the mines are drifts with natural drainage, and less than a dozen of them are shafts, the deepest shaft being only 230 feet deep. Many of them have soft underbeds and hard covers. The equipments of many of them are very extensive and most modern. The drainage of more than half of them, as has been stated, is natural. The mine waters of the others are collected together by ditches, siphons, and small pumps, and pumped out through the main entries and air shafts. The ventilation of nearly all of them is good, and is effected by fans and furnaces, or by the escape of the heat from the underground boilers, exhausts, etc., up the air shafts. Gravity and automatic devices are made use of in the working of many of them. They are all, with perhaps one exception on the longwall system, so far as known, worked on the pillar-and-stall method.* A new plan on this method is now in use in some of the larger mines. This new plan is to extend the heading to its final limit before turning off any rooms, and then to commence at the end of the heading with the rooms and work backward with them. The pillars are not left standing very long but are soon withdrawn. After this method, the mine is better ventilated and there is less loss of coal.

Endless wire-rope haulage is very extensively used in most of the larger mines. An improvement on this haulage has also been made, by means of which the cars come and go in one continuous flow instead of in batches or trips as by the old way and by the tail-rope system, and so the deliverance by it or the capacity of a mine is not affected by distance of haulage as in the case of the other older methods. It can be and is used not only for underground hauling, but also for slope hauling to and from the tippie, as shown in the accompanying photograph. The cars travel slowly and the rope is carried for the most part swinging between the cars, and so there is least danger of accidents and of wear and tear on the rope, running gear, etc. This new overhead endless-rope system of haulage is to be seen at New Slope No. 3, and at Slopes Nos. 6 and 7, Pratt Mines. The endless-rope haulage of Slope No. 6 is said to be two and a half miles long, which requires five miles of wire rope, and ten miles of single thirty-pound rail.† On these long haulage lines, electric signals can be sent to the engineer from any point on the haulage by the touching or the connecting with a piece of steel two wires that run the whole length of haulage. The wires are used also for telephoning purposes.

The coal mines of Alabama gave employment to some 10,000 miners and 3,000 day men in 1899. About 50 mining machines were in use during that year. Labor troubles are comparatively few. The output of these mines is moved by some 12 different railroads. These figures, though good for 1899, are not good for the present state of things, as new mines are constantly being opened and new railroads are being built, and yet the present output is not equal to the present demands.

The coals of Alabama are of almost every variety of bituminous coal, though no very great trouble has been experienced in the mines from the presence of super-abundance of gas. They show on chemical analyses and by practical tests and uses on a large scale to be equal in quality to the bituminous coals of other States. They are used principally for coking (furnace and foundry purposes), steam, gas, blacksmithing, and domestic purposes. They are separated for the most part by improved shaking screens into lump, nut, and slack coal. The lump and nut coals go mostly to the general markets for steam and domestic purposes, while the slack is principally coked, though some of it is used for

blacksmithing after being washed. The principal markets for these coals are within the State, though they go to supply South Carolina, Georgia, Tennessee, Mississippi, Louisiana, and Texas; steamships at Mobile, Pensacola, New Orleans, and Savannah; and the export trade, principally to Mexico. The home supply is mainly for coking (iron ore smelting), while the commercial shipments are mostly for steam purposes, supplying more or less almost every railroad in the South. The Mississippi River barge line trade of coal delivered at Greenville, Miss., is beginning to assume large proportions.

The coke industry in Alabama has grown even faster than coal mining. It was not known until in 1876 that the Alabama coals would make good coke, suitable for smelting, and now Alabama ranks third of the States of the Union as a coke-producing State, being surpassed only by Pennsylvania and West Virginia. The coke output of the State for the calendar year 1899 was given by the State Mine Inspectors at 1,798,612 tons. This coke was used principally within the State for iron-ore smelting, though a considerable portion of it was shipped to other States and to Mexico for smelting and foundry purposes. The present output does not begin to supply the present demand. Many new ovens are being built. The output of 1899 was made in something over 5,000 ovens, all of the beehive pattern with the exception of 120 of the Semet-Solvay. There are 63 Thomas ovens in the State, though they have not been running for several years.



SLOPE No. 4, PRATT MINES, ALA.

The coke is made principally from washed slack, though the entire output of some of the coal mines is crushed, washed, and converted into coke. The washed coke is allowed to drain in bins before coking. The heat and gases from the ovens are allowed to go to waste with the exception of one case besides that of the Semet-Solvay byproduct plant. In that exceptional case, the heat and gases from the ovens are converted into steam to heat boilers, etc. The Semet-Solvay plant is said to deliver to the steel works for its use over a million cubic feet of coke-oven gas daily. The use of the heat and gases from these two plants is a very great saving in steam coal. The plant of 120 Semet-Solvay ovens is now being duplicated. The coke output for 1900 has been estimated at 2,150,000 tons.

The coal fields of Alabama are worthy of notice not only because of their workable coals of good quality and large quantity but also because of their fine building and paving stones. The building stones are durable and easily worked. The stones for the government locks along the Warrior River above Tuscaloosa, beautiful and lasting pieces of masonry, were gotten from the bed of the river in blasting out the channels leading to the locks, and from quarries on the river banks close at hand. The paving stones are often of great regularity with beautifully smooth and ripple-marked sides. In places, they are of such uniform thickness as to be called plank rocks. Coaly black band ore occurs at

* MINES AND MINERALS, December, 1900, Alabama Mining Methods.

† See MINES AND MINERALS, December, 1900, for description of the haulage system.

several horizons. The coal fields are still, for the most part, covered by their virgin forests of long- and short-leaf pines, oaks, gums, hickories, beech, poplar, etc.

WARRIOR COAL FIELD.

This coal field has attracted the most attention of the coal fields of Alabama, because of its much larger size and, as a general thing, much smaller dip of its strata or the greater coal exposures and greater coal that can be mined with ease and cheapness above drainage level. It is the most northwestern of the three coal fields and, as generally understood, comprises all of the coal measures of Alabama that are drained by the Warrior and Tennessee rivers, together with an outlier, Lookout Mountain, that is drained into the Coosa River. Thus defined, it embraces some 7,800 square miles or is 10 times as large as the other two fields combined. It consists of a *plateau* and *basin area* without any distinct line of demarcation between the two, the one gradually merging into the other.

The *plateau* is the smaller northeast half of the field. It is the broad elevated plateau of the southwest end of the Appalachian Mountains as they slope towards the southwest from an elevation of some 800 feet above the adjacent valleys, 1,200 to 1,800 feet above sea level, until they sink below the drainage level or pass imperceptibly into the *basin area*. This plateau owes its existence to, and is made up principally of, the hard weather-resisting sandstones and conglomerates near the base of the coal measures. It is divided into two parts by an anticlinal valley that as an undented anticlinal ridge extends down into the *basin area*. Its measures are very variable, ranging from a thickness of 100 feet or less with one or more seams of coal to a thickness of some 1,500



SECTION OF BLUE CREEK COAL VEIN IN ADGER SLOPE.

feet or more with some 14 or more different seams of coal. Its coals, especially, are very variable, occurring in squeezes and thick pockets. Only about four of its coal seams appear to be always present, only about six of them to be ever of workable thickness, and only two of workable thickness other than in a few places. They are, as a general thing, thickest and most reliable in the extreme northeast part of the field, next to the Georgia and Tennessee lines. Their coals are usually of good quality, though in places they carry considerable pyrite. They are hard and solid and not very bituminous. They have been worked considerably, but, owing to their unreliability or irregularity of thickness, they are now worked in a commercial way, on a small scale, in only two or three places. Their output for 1899 was not over 10,000 tons. They, however, get better towards the northeast, and furnish all of the workable coals of Tennessee and Georgia.

The *basin area* is the larger southwest half of the Warrior Coal Field. It is drained entirely by the Warrior River and its tributaries. There is no way of telling how far its strata may extend to the west and southwest, as they become covered up by newer formations. It may be said to comprise all of the strata of the Warrior Coal Field above those of the hard, weather-resisting sandstones and conglomerates near the base of the coal measures. In a general way, it is more broken than the *plateau*. There is cut off from its southeast side by a combined fold and fault a strip some 12 miles long by 4 in width that is known as the *little basin*. The strata of this field have a general dip to the southwest that is greater than the inclination of the surface of the country and so the measures thicken to the southwest until they become covered up. Their most southwest visible strata, forming the University Shoals, at Tuscaloosa, the first rocky obstructions in the Warrior River, are the most southwest of the great Appalachian system so far as can be seen. They

reach a maximum thickness near their southwest end of some 2,000 feet over the *plateau* strata, with some 23 different seams of coal. These coal seams range in thickness from a few inches to some 16 feet, though the thicker seams carry more or less slate as partings. The maximum thickness of coal is near 125 feet. The seams, in a general way, split up and thicken towards the southeast, the center of the original coal basin, and come together and thin out towards the northwest, the edge of the original coal field. They all, however, with the exception of two, carry more or less workable coal, 2 feet and over in thickness, on their outcrops.

The coals of this field, though they were not mined any in a systematic underground way until 1872, furnished 6,125,419 tons for the output for the calendar year 1899. This output came from 9 different counties with 157 producing mines (112 drifts, 36 slopes, 9 shafts), though one county (Jefferson) with 80 producing mines (48 drifts, 31 slopes, 1 shaft) furnished much the greater part of it or 4,774,478 tons. This county, Jefferson, with the Southern iron center, Birmingham, therefore furnished from its Warrior Coal Field considerably more than one-half of the coal output for the State for the calendar year 1899.

This coal field has some of the largest bituminous coal plants in the world. One of its companies, the Tennessee Coal, Iron, and Railroad Company, has in this field 22 mines (12 drifts, 9 slopes, 1 shaft) that furnished 2,771,921 tons of the coal output for the calendar year 1899.

Most of the coals of this field are free burning coals that are good not only for coking purposes but also for steam and domestic purposes. They furnished more than 1,722,838 tons of the coke output for the year 1899. They are the main dependence of the coke furnaces of the State. Most of the coals have a regular face and butt structure, or a joint structure that divides them up into cubical and rhomboidal blocks, though some of them are hard and compact throughout. Some of them carry thin seams of mineral charcoal. This coal is hauled off from the mines by ten different railroads.

CAHABA COAL FIELD.

This is the middle one of the three coal fields of Alabama, and contains the most southern true coal in the United States. It is a long narrow field of from 60 to 70 miles in length with an average width of less than 6 miles and a maximum width of some 15 miles, and an area of over 400 square miles. It, in a general way, gradually widens towards the southwest. It is drained entirely by the Cahaba River that runs down it almost its whole length. It is bounded on the northwest by an elevated rim, and on the southeast by a great thrust fault of over two miles vertical displacement. It also has through its broader southwest end an interior fault with vertical measures, and a vertical displacement of from 700 to 1,500 feet. It has other smaller faults along near its southeast edge and some overturned strata that lap over towards the northwest. It is made up of a series of basins, some 11 in number. Outside of the flat and undulating strata of these basins and the vertical strata, the general dip is to the southeast, and so the field as a whole is a monoclinical basin. This dip, in a general way, increases towards the southeast. The thickest measures are therefore near the southeast edge of the field and the southeast edges of the basins. These thickest measures are some 5,500 feet thick with some 50 different coal seams and a maximum thickness of coal of nearly 100 feet. The coal seams range in thickness from a few inches to nearly 10 feet. About one-half of them are of workable thickness, 2 feet and over, in places at least. They are much less above drainage level and crop out in much more limited areas than do those of the Warrior Field, because of their greater dip. They were the first coals in Alabama that were mined in a systematic underground way, as far back as 1856, but it was not until the seventies that they were mined to any extent. They furnished about 1,306,329 tons of the coal output for the calendar year 1899. This coal came from 8 different seams and 20 different mines (19 slopes, 1 shaft), and was hauled away from the mines by 6 different railroads. These coals, as a general thing, are of fine quality. They are somewhat harder and cleaner than the Warrior coals. They are bright and shiny and unusually free from pyrite. Some of them are good coking coals, and some of them are as fine steam and domestic coals as can be found in the United States. Large quantities of them are exported to Mexico and South America.

COOSA COAL FIELD.

This is the smallest, least known, least productive, and most southeasterly of the three coal fields of Alabama. It, too, is a long narrow field of some 60 miles in length with an average width of less than 6 miles and an area of over 800 square miles. It is made up of basin-like areas, seven in number. Its southwest portion is divided into two separate parts by a narrow valley that has been washed down into the underlying strata. It is drained entirely by the Coosa River. It is bounded on the northwest by

high mountains, and on the southeast mostly by a big thrust fault. It is a mountainous and broken country. Its highest peak is some 1,600 feet above sea level. It is nearer the axis of the great Appalachian revolution than the other two fields, and so its strata are more broken up and faulted. Its general dip, outside of the undulating strata of the basins and the vertical strata along the faults, is to the southeast, and so it is mostly a monoclinical basin and its thickest measures are along close to its southeast edge and the southeast edges of its basins. It is known to have some 17 to 18 different seams of coal above the mountain making rocks (conglomerates and sandstones), here very highly developed near the base of the measures. Some 7 to 8 of these seams are of workable thickness, 2 feet and over, at least in places. The most reliable of them, however, or those that are thickest and best are near the top of the thickest measures and underlie but small areas. These coals have been worked in a commercial way only in the northeastern part of the field, and these only to a limited extent. Only 2 of them were worked in a commercial way in 1899. They were worked by slopes and gave an output of about 52,252 tons for the calendar year 1899. These coals are remarkably free from dirt and pyrite. They are however comparatively soft and friable, unsuited for stocking but well suited for cooking. They are hauled away from the mines by the East and West Railroad of Alabama.

REFERENCES.

The coal fields and coals of Alabama have been treated of in the following State Geological Reports: (1) First Biennial Report, 1850, out of print; (2) Report of Progress for 1875, postage 5 cents; (3) Report of Progress for 1877-78, out of print; (4) Report of Progress for 1879-80, out of print; (5) Report on the Warrior Coal Field, 1886, out of print; (6) Report on the Cahaba Coal Field, with Map, 1890, postage 11 cents; (7) Report on the Coal Measures of the Plateau Region of the Warrior Coal Field, 1891, postage 5 cents; (8) Report on the Coal Measures of Blount Mountain of the Warrior Coal Field, 1893, out of print; (9) Report on the Coosa Coal Field, 1895, postage 4 cents; (10) Report on the Warrior Coal Basin, with Map, 1900, postage 16 cents.

The above reports are sent, free of charge (except No. 10, price \$1.00), on receipt of postage by the State Geologist, University, Ala.

The Durkee Electric Drill.

It has long been known that the air drill in general use in mines, while a very satisfactory machine as regards the work which it does, is of very low efficiency. It is not believed that more than one-tenth of the power of the steam in the cylinder of the compressor is delivered upon the rock at the bottom of the drill hole. This is not chargeable to the air drill in itself, but to the entire group of machinery through which the air drill is driven. As an instance, the air-compressing cylinders are water-jacketed to carry away the heat of compression of the air, which heat is essential when the air is expanded, if the air is to develop a fair proportion of the power expended in its compression. This is but one of the unavoidable losses due to the system of rock drilling by compressed air.

The air drill has been in use so long a time that the mechanical defects are in the main eliminated. The accessories have also undergone as rapid improvements as the air drill proper.

On account of the low efficiency of the air drill and its consequent high cost of installation and of fuel for operation, a great amount of study has been spent on the subject of more economical rock drilling. One of the results of this study is the Durkee Lightning Drill, which has recently been placed in the market by the Mine & Smelter Supply Co., of Denver. The Durkee drill is operated by a small electric motor through a short flexible shaft, and uses but one and one-quarter horsepower at the motor to do the work of a two and one-half inch air drill. The Durkee drill follows as far as possible the best practice, as established by the air drill, using the same style of column, arm, clamp, guide shell and feeding device, chuck and rotating devices. The method of application of the power to the bit is, of necessity, entirely different from the air drill. The rotary motion of the motor is transmitted through a flexible shaft to a crank-shaft in the drill, which oscillates a heavy bell crank in such a manner that the piston rod carrying the bit is given a quick motion toward the rock, while the return stroke is much slower and of increased power. This gives a sharp blow to the rock and a strong pull to release the drill from a rifled hole. The power is delivered to the piston rod through buffer springs, which springs, however, are not required to deliver the blow by their expansion. Careful attention has been paid to simplicity and ease of repair, and as a result any part can be taken out and replaced in a few minutes without removing the drill from the column.

The Mine & Smelter Supply Co., who are agents for the

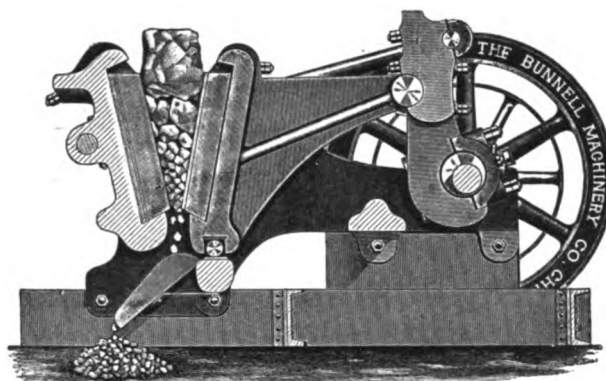
Durkee drill, have spent several months in carefully testing it in actual mine work, and have proved that the results are entirely satisfactory. The drills are now running in mines in Colorado, Utah, Arizona, and Idaho, and other States, and in all cases the reports are most favorable. All users concur in saying that the Durkee drill is as effective and easy to run as the air drill, while the power required is less than one-tenth that required by the air drill. From these reports it appears that a great stride forward in economical mining has been taken.

The Bunnell Rock and Ore Crusher.

The accompanying illustration shows an ore and rock crusher which is being manufactured by the Bunnell Machinery Co., Suite 1612-1617, Old Colony Building, Chicago, Ill. This machine should invite the careful attention of mining men chiefly for two reasons which are apparent upon the face of the cut shown. First, its remarkable simplicity, and second, the lightness of its parts.

The makers claim for this crusher the following characteristics: Lighter weight; very much greater strength; fewer oil bearings and less number of parts than any other machine; less engine power; greater amount of production; a rapidly applied hammer blow, insuring better form of product; the tension strain is borne by forged steel, and the compression strain by cast iron and semi-steel; the machine has no steel or rubber springs to wear out; it crushes at some parts of the jaw all the time; the eccentric shaft can never flatten, the strain being evenly distributed upon all parts.

The manufacturers of this machine claim that they have sought for and obtained a machine which while amply strong for the severest test, is lighter by a good many thousand pounds than



THE BUNNELL ROCK AND ORE CRUSHER.

any other machine ever produced to do an equal amount of work. The advantage of this feature will at once appeal to miners whose property is located a long distance from transportation and where supplies must be carried on pack mules, or in other slow and difficult ways.

The machine is manufactured in three sizes and its various parts are constructed of such material as is best adapted to meet the particular strains placed upon it; for example, the compression strain is borne by cast iron, cast steel, and steel members, and the tensile strains by steel bars drawn from a solid piece of metal. The capacities covered by the several sizes are equal to the needs of any plant and the quantity and quality of product are excelled by none.

The machine has but thirty-one parts and four oil bearings. These parts indicate the small amount of power required to operate this machine, as it runs with a minimum amount of friction.

The company manufactures and deals in a full line of earth-handling, road-making, and quarry and mining machinery, including screens, elevators, engines, boilers, hoists, road graders, wheel and drag scrapers, plows, steam and horse rollers, sprinkling wagons, and the Bunnell automobile steam grader and ditcher.

A new 64-page catalogue, containing illustrations and detailed descriptions of the product of the company, has just been issued, and will be furnished on application if those interested will mention MINES AND MINERALS.

An important factor in the economical performance of any engine, and one which seems to have been entirely disregarded by some of the most reputable engine builders is that of clearance. As to the economy of small clearance there is no longer any question, and yet there are high grade engines on the market in which the clearance is so great that great economy is impossible.

Mines and Minerals

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ECONOMIC VALUES BELOW CITIES.

WHEN we have long become accustomed to a thing, we are apt to settle down to it with an "always was, is now, and ever shall be" sort of sentiment till we are awakened up, it may be, by a wide awake progressive man of science, or by some scientific man who knows how to apply his science. Take some large city we have lived in from our father's time which has existed many years, perhaps for generations. We have never thought about that city being underlaid with valuable coal, oil or gas at available depths—never bothered ourselves with the idea; no one ever suggested it, although we all knew that coal or oil existed and was developed in the surrounding country. Some geologist comes along and with little respect for houses, streets, and city conventionalities, regards the city as a geological problem and forthwith declares that from careful observations made in the neighborhood, or from his own geological knowledge, the results of experience, he is convinced that the city is underlaid by coal, or it may be oil or gas.

As a case in point look at the discoveries of oil underneath Los Angeles, California. Little did the earlier inhabitants and real estate men, when they laid out their parks and erected their beautiful houses in that notoriously beautiful city, imagine that in a short time their grass plots and parks would be invaded by a forest of oil derricks, and the finest residence portion of the city be reeking with the odor of oil, as the result of the enterprise of one or two citizens. From an æsthetic point of view it might have been wished that that beautiful city had been spared such a discovery within its limits and that oil had been found farther from it.

There are possibly other cities that have values beneath them yet if people only knew it, or felt it worth while to try and look for them. Would it not be well if the formations below the site of every important city were geologically surveyed. Because an area of ground is overlaid with well paved streets, residences, churches, etc., there is no reason why it may not be underlaid with economic values as much as the adjacent unsettled territory around it; yet to this latter the public, as well as the geologist more often naturally turns than nearer home.

There is every reason to believe from a geological point of view that the city of Denver is underlaid at a depth within or not greatly exceeding 2,000 feet, with a coal seam, it may be 6 or 8 feet thick, more or less, but probably from the superabundance of coal in Colorado, it would not pay to put down a shaft of that depth in the heart of the city. Again it was a long time before Denver thought of boring artesian wells and looking for artesian water, although she was annually suffering from typhoid fever, the result of bad surface water and drainage. Nor was it scientists or geologists that first started the artesian experiment or even suggested the idea, but a local brewer, who without any scientific knowledge, thought he would try for better water than he had for his brewing purposes by a little experimental boring. It is not always the scientist that leads the public on to important discoveries, but sometimes an amateur, it may be, or a non-professional man. Commonly these discoveries are purely accidental.

MINERAL EXPORTS.

VERY few of those directly connected with mining enterprises probably realize the very important part which has been and is at present being taken by our mineral products in the rapidly increasing export trade of the United States.

For so many years, this country has been the granary of Europe that we have become used to thinking of our exports as being mainly of food products. It comes therefore as a pleasant and gratifying surprise to learn that, out of a total value of exports for 1900 of \$1,565,228,606, crude and manufactured mineral products, that is, products which were originally beneath the surface of the ground, constituted 28 per cent. of the whole, valued at \$436,227,477.

The following table recently issued by the Bureau of Statistics of the Treasury Department in Washington, is interesting, since it shows the items which makes up this enormous total of mineral exports. It also shows the great advance which has been made along this line during the past decade by this particular branch of American industry, that is, the production and manufacture of the mineral wealth, with which nature has so bountifully supplied the United States.

Articles Exported.	1890.	1900.
Iron and Steel and manufactures (not including iron ore)	\$27,000,134	\$129,788,236
Mineral oil	52,270,943	74,494,707
Copper and manufactures	5,918,395	58,881,529
Coal and coke	7,277,632	22,883,047
Paraffine	2,920,262	8,185,518
Scientific Instruments	1,500,369	6,788,938
Phosphates	1,818,439	5,217,560
Cycles		8,060,161
Zinc and manufactures	344,991	2,316,981
Clocks and watches	1,591,836	2,104,819
Brass and manufactures		2,068,072
Copper sulphate		2,040,989
Jewelry and plated ware	1,225,077	1,810,480
Marble stone and manufactures	918,321	1,556,981
Nickel		1,382,727
Tin	262,343	467,332
Lead and manufactures	521,961	459,571
Quicksilver	93,192	425,812
Cement		225,306
Total domestic merchandise	103,693,955	324,167,266
Domestic gold exported	20,654,960	52,787,523
Domestic silver exported	16,098,189	59,272,668
Total minerals, metals, and M's	140,447,104	436,227,457

This table shows that of manufactured iron and steel, five times as much was exported in 1900 as in 1890; of copper, nearly ten times as much; of mineral oil, 50% more; of coal and coke, three times as much; and of gold and silver, three times as much.

Meantime, imports of this character have materially decreased, except in case of natural products not obtained from the mines of the United States, but required for use in manufacturing. Imports of manufactures of iron and steel, for instance, fell from \$41,679,501 in 1890 to \$20,443,908 in 1900; while pig tin used in the manufacture of tin plate has increased from about six and a half millions in 1890 to \$19,458,586 in 1900.

ECONOMIC VALUES OTHER THAN GOLD AND SILVER TO BE FOUND IN THE ROCKY MOUNTAINS.

NEVER in the experience of the Rocky Mountain region has there been such a demand and inquiry for all sorts of minerals and mineral products of economic value, other than gold and silver, as in the past year or two. In the evolution of Colorado and many of the Western States and Territories along the eastern flank of the Rocky Mountains, stock raising was first developed; then came gold mining, principally from placer deposits with the prospectors' crude appliances; then a big silver mining era followed, and since the fall in silver a second and more important gold mining era from vein deposits in place.

Gold and silver for a long time occupied men's energies almost exclusively. Gradually, however, attention has been turned to economic products of a more utilitarian and baser sort, but which occur on a large scale and in many cases are of no less value than the precious metals. Vast coal fields were found, producing coal of all varieties from lignite to coking coal, and anthracite. The great clay deposits of the Rocky Mountain slope were investigated and refractory fireclays equal to any, and superior to most in the world, were found, as well as excellent press brick and terra cotta clays, and large works on these were established along the zone of foothills. Limestones were quarried for flux or burnt for lime.

With the use and demands of our greater cities, attention was turned to the building and ornamental stone capacities of the Rockies. Red and gray granites were found of excellent quality and color, and marbles of all colors and shades were found in deposits of great thickness, purity and beauty. A little investigation also soon discovered the elements for making Portland, Roman, and other cements.

Petroleum oil was wanted. Some said there was none to be found east of the Missouri River, outside the well-known fields. Investigations were made and oil in abundance was found at Florence, near Cañon City, Colorado, with indications of it in several other parts of the State, not to mention States and Territories west of the Rockies, which are now, while the oil fever is on, being investigated in a manner never before dreamed of, and though many speculators will get bit and many a well prove dry, yet there is every reason to believe that the oil fields of Colorado, California, and other Western States, will be largely increased in number and in producing area before the year closes.

People are beginning to recognize that the foothills and heart of the great Rocky Mountain upheaval contain within them, and have brought within accessible reach, nearly all the known minerals of economic value that the earth possesses. You have as it were only to mention a mineral of economic value to go out into the hills and find it.

Whilst there has been so great demand for the larger and more ordinary products of the hills and rocks, there has come of late a seeking after all sorts of rare, or hitherto somewhat overlooked, minerals of economic value such as uranium, tungsten, molybdenum, corundum, bauxite, bismuth, manganese, alunite, arsenic, asbestos, asphaltum, cobalt, carnotite, cinnabar, nickel, tin, cryolite, infusorial or fullers' earth; epsomite, fluorspar, natural gas, geyserite, graphite, grindstone rock, hübnerite, kaolin, lithographic stone, magnesite, antimony, rutile, vitriol, wolframite, not to mention the various precious stones such as topaz, ruby, agate, turquoise, amazon stone, beryl, garnet, and many others.

All of these mentioned are to be found in more or less available and commercial quantities somewhere in the Rocky Mountain uplift, and for all of these there has been more or less call and inquiry, especially within the past year or two.

In this connection, the good work of the State Mining Bureau, of Colorado, in collecting data and giving information broadcast on these subjects, will be appreciated.

SPECIAL OFFER.

AFTER June 1, 1901, the following very liberal special offer in connection with MINES AND MINERALS and The Coal and Metal Miners' Pocketbook will be withdrawn:

To any subscriber to MINES AND MINERALS, whose subscription is paid six months, or more, in advance, and who sends us a new prepaid subscriber for MINES AND MINERALS, we will send a copy of The Coal and Metal Miners' Pocketbook, sixth edition, free.

The Coal and Metal Miners' Pocketbook has been highly recommended by mining men everywhere and within two weeks of its appearance had been adopted as a textbook by the leading mining schools and colleges of the United States and Canada.

BOOK REVIEW.

"JAHRBUCH" FOR THE YEAR 1900, by C. Menzel. Published by Craz & Gerlach, Freiberg, Germany. Price 8 marks. 252 pages.

ANNUAL REPORT OF THE DIRECTOR TO THE BOARD OF TRUSTEES FOR THE YEAR 1899-1900. Published by Field Columbian Museum, Chicago, Ill. 512 pages.

MINING LAW OF WEST VIRGINIA AS AMENDED BY THE LEGISLATURE IN REGULAR SESSION OF 1901. Published by James W. Paul, Chief Mine Inspector, Charleston, W. Va. 25 pages.

UNITED STATES GEOLOGICAL SURVEY, Washington, D. C. Extracts from the Annual Report for 1899. The Production of Lead in 1899, by Chas. Kirchhoff. 27 pages. The Production of Salt in 1899, by Edward W. Parker. 28 pages. The Manufacture of Coke in 1899, by Edward W. Parker. 117 pages. The Production of Copper in 1899, by Chas. Kirchhoff. 65 pages.

THE REPORT OF FOUR INSPECTORS OF MINES TO HIS MAJESTY'S SECRETARY OF STATE FOR THE HOME DEPARTMENT, ON THE METHODS OF PREVENTING FALLS OF ROOF ADOPTED AT THE COURRIERES COLLIERIES. Printed by Darling & Son, Ltd., 34 Bacon St., E., London. 26 pages.

COAL MINING. An elementary textbook of mining, illustrated; by Robert Peel. Blackie & Son, Limited, London; J. B. Lippincott Company, Philadelphia. 300 pages. Price \$1.00. The author expresses the hope that this book may supply the need for an elementary textbook at a price that will be suitable for beginners. The book is a primer of coal mining.

A COMPENDIUM OF GOLD METALLURGY AND DIGEST OF U. S. MINING LAWS, WATER RIGHTS, DESERT LAND LAW, ETC., by E. M. and M. L. Wade, B. Sc. Second edition, revised. Price \$1.00. 140 pages. Los Angeles, Cal. This is really a catalogue and advertisement for Messrs. Wade & Wade, analytical chemists and assayers, and while it contains interesting information, it is manifest to any one acquainted with the subject of gold milling and metallurgy that in a space of less than 100 small pages it is impossible to treat with any degree of satisfaction the entire subject of the metallurgy of gold.

PETROLEUM IN CALIFORNIA. A concise and reliable history of the oil industry of the State. Compiled and published by Lionel V. Redpath, 405 Blanchard Building, Los Angeles, Cal. 160 pages. Price \$1.00. This work contains, in addition to a number of papers of geological interest taken from the reports of the California Mining Bureau, a somewhat detailed description of the different oil fields in California which are creating so great an excitement at the present time. It is not a technical work, but will probably prove of interest to many who are looking for a more or less popular description of the subject.

NINTH ANNUAL REPORT OF THE STATE INSPECTOR OF COAL MINES OF THE STATE OF WASHINGTON. C. H. Owen, Inspector of Coal Mines, Olympia, Wash. From the preliminary remarks of the inspector, we are forced to conclude that there are very many matters in connection with the coal mines of Washington that need revision and regulation. The inspector hints at these things, but says that it is not consistent with public service to make mention of matters of difference between himself and superintendents in charge of mines, which have been satisfactorily adjusted. The report contains the usual statistics and a brief account of each mine in the State.

SCIENCE AND ART OF MINING. Handbooks for Mining Students and Colliery Managers. Second Edition Revised. Two Volumes. Published by the Science and Art of Mining, Rowbottom Square, Wallgate, Wigan, England. Price \$1.10 per volume, postpaid. Volume I is made up of five parts as follows: Part I.—Geology; Surveying; Lighting of Mines; The Coal Mines Regulation Act. Part II.—Boilers and Fittings; Heat and Steam; Steam and other Engines. Part III.—The Furnace and other Methods of, and Problems in, Ventilation; Ventilation by Machinery; The Anemometer, Barometer, Thermometer, Water-Gauge, Hydrometer. Part IV.—Boring and Sinking; Methods of Coal Working; Blasting in Coal Mines. Part V.—Winding Machinery; Hauling Arrangements; Ropes, Chains, Conductors, Safe Winding Appliances. Volume II contains the following: Part VI.—Pumps and Pumping Engines; Pump Details and Examples. Part VII.—Practical Mechanics for Practical Men. Part IX.—Miscellaneous Mechanics; Miscellaneous Engineering. Part X.—Useful Notes. Part XI, XII.—Mining Dictionary. The contents consist of a series of questions and answers upon the subjects given above, without illustrations, and following the general system which has been taken by a number of other English books. This book will be useful for a person wishing to study the subjects treated, but for reference books they are of little value on account of the absence of any form of index. The glossary at the end of Volume II will be found useful, as it is quite complete and has been compiled from a number of other glossaries previously published.

REPORT OF THE GEOLOGICAL SURVEY OF NORTH DAKOTA. First Biennial Report, E. J. Babcock, State Geologist, Grand Forks, N. D. 91 pages. This first report, although a short one, is very admirably done, and it is to be hoped that Prof. Babcock will be given better facilities for prosecuting and carrying on the work which he has so well begun and which he has carried on for some years past under very disadvantageous conditions. The report contains interesting chapters upon the topography and geology of Dakota, the clay and coal deposits, and the water conditions throughout the State, together with a large number of analyses of these various products made at State University with which Prof. Babcock is connected. The printing of the book is far below the standard which its contents call for, but in this respect the author is undoubtedly not to blame, for with the limited appropriation he is undoubtedly not justified in putting an undue proportion in typography.

GAS AND COAL DUST FIRING. A critical review of the various appliances patented in Germany for this purpose since 1885, by

Albert Pütsch. Translated from the German by Chas. Salter. Published by Scott, Greenwood & Co., 19 Ludgate Hill, E. C. London; D. Van Nostrand Co., New York, agents. Price \$3.00. 122 pages. The present volume was written by the late Albert Pütsch as a complement to his preceding treatises on the subject, and in it he has taken up all patents which have been granted since the appearance of his last work. The work is copiously illustrated with drawings of different furnaces, and these will be welcome, as the literature upon dust and gas firing has been rather scanty. The scope of the work is shown by the following chapter headings: Generators, Generators Employing Steam, Stirring and Feed Regulating Appliances, Direct Generators, Burners, Regenerators, and Recuperators, Glass Smelting Furnaces, Metallurgical Furnaces, Pottery Furnace, Coal Dust Firing.

THE STORY OF NINETEENTH CENTURY SCIENCE, by Henry Smith Williams, M. D. Illustrated. Published by Harper Brothers, New York. 457 pages. Price \$2.50. The readers of Harper's Magazine will be very glad to have in permanent book form the very interesting series of scientific articles which originally appeared in that magazine several years ago. These are now presented in book form, as noted above, well printed and copiously illustrated. The chapters of particular interest to mining men are those on Paleontology, Geology, and Chemistry. The other subjects taken up are Science at the Beginning of the Century, the Century's Progress in Astronomy, Meteorology, Physics, Biology, Anatomy and Physiology, Medicine and Psychology, with a concluding chapter upon Some Unsolved Scientific Problems. It is of interest to mining men to see that the first scientist spoken of in the first chapter and the first one whose photograph appears in the text of the book is Sir Humphrey Davy to whom the mining world owes such a debt of gratitude for the safety lamp.

TENNESSEE BUREAU OF LABOR STATISTICS AND MINES. 10th Annual Report, R. A. Shiffett, Commissioner of Labor and Inspector of Mines, Nashville, Tenn. 287 pages. This report contains a varied amount of general information in regard to coal and other mineral products and general labor conditions, aside from the purely local statistics for the State of Tennessee. The statistics for the State are briefly though interestingly presented without undue elaboration, and the similar statistics taken from other reports for the same industry in other States permit the reader to see the relative importance of the industries of Tennessee compared with those of other States. The work is almost entirely given up to statistics of mines, and the several popular technical articles contained in it are timely. In giving the detailed report of coroners' inquests, the labor commissioner is simply following the custom which is followed in a great many similar reports and which is an entirely useless waste of space. The table of officers of the National Association of Labor Statistics and the data in regard to the several State bureaus is interesting and valuable.

RECOVERY WORK AFTER PIT FIRES. Translated from the German of Robert Lamprecht, Mining Engineer and Manager, by Charles Salter. Scott, Greenwood & Co., London; D. Van Nostrand Co., New York. Price \$4.00. Illustrated by seven large plates containing 76 figures. 175 pages. The book is a description of the principal methods pursued and appliances employed in the work of recovering a mine in case of a mine fire, or rescuing the victims of a mine explosion. The author of the book has entered a new field and one that is of great interest to all students of mining, as this is at present the only book that treats upon this subject exclusively. The author's treatment of the subject is practical throughout. The various causes of mine fires are first reviewed and illustrations given of such fires in different collieries where many lives were sacrificed. Preventive measures and precautions to be adopted are then considered, and in this, the author's experience and observations furnish many valuable suggestions. Much attention is given to the description of appliances for working in irrespirable gases, as the author has recognized the fact that the fatal afterdamp of an explosion destroys more lives than the explosion itself. The employment of electricity in mine observations is also considered in relation to its being a factor in the ignition of firedamp. Indications of existing mine fires and the methods to be employed for extinguishing them are discussed, including a full description of the manner of building mine dams, as well as the use of portable dams. The book is written in an interesting style and its value very much enhanced by numerous references to incidents in the experience of the writer and to other authorities.

STEAM-BOILER ECONOMY. A treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers, by Wm. Kent, A. M., M. E. Published by John Wiley & Sons. Price \$4.00. 458 pages. Readers of MINES AND MINERALS will recognize in this volume considerable material with which they are already familiar, as much of it appeared in a series of articles upon Steam Boilers for Mine Use written for MINES AND MINERALS, by Mr. Kent during

the years 1896, 1897, and 1898. His articles have, however, been very greatly elaborated and now apply to steam-boiler practice in general. The scope of the book is shown by the following chapter headings: 1. Principles and Definitions. 2. Fuel and Combustion. 3. Coal. 4. Coal Fields of the United States. 5. Tests of the Heating Value of American and Foreign Coals. 6. Fuels other than coal. 7. Furnaces, Methods of Firing, Smoke Prevention, Mechanical Stokers, Forced Draft. 8. Some Elementary Principles of Boiler Economy and Capacity, The Plain Cylinder Boiler. 9. Efficiency of the Heating Surface. 10. Types of Steam Boilers. 11. The Horsepower of a Steam Boiler, Proportions of Heating and Grate Surface, Performance of Boilers. 12. Points of a Good Boiler. 13. Boiler Troubles and Boiler-User's Complaints. 14. Evaporation Tests of Steam Boilers. 15. Results of Steam-Boiler Trials. 16. Properties of Water and Steam, Factors of Evaporation, Chimneys. 17. Miscellaneous. Mr. Kent has compiled a large amount of statistical matter in regard to the coals of the United States which will be very welcome, and this portion of the book adds materially to its value. The book is just now very timely when so much interest is being taken in the subject of American coal and the best methods of its utilization. It is copiously illustrated, and well printed, and will prove of great value to all having to do with steam boilers.

THE RISKS AND DANGERS OF VARIOUS OCCUPATIONS, AND THEIR PREVENTIONS, by L. A. Parry, M. D. Published at the offices of the Oil and Colourman's Journal, Scott, Greenwood & Co., 19 Ludgate Hill, London. D. Van Nostrand Co., New York, agents. Price \$3.00. 192 pages. This work is intended mainly for employers of labor, for foremen, and for workmen connected with occupations where they are subject to danger, mainly from poisons, and it does not refer particularly to the ordinary accidents. The Table of Contents shows the following chapter headings which give the scope of the work: 1. Occupations which are accompanied by the generation and scattering of abnormal quantities of dust. 2. Trades in which there is danger of metallic poisoning. 3. Certain Chemical Trades. 4. Some Miscellaneous Occupations. 5. Trades in which Various Poisonous Vapours are inhaled. 6. General Hygienic Considerations.

The portions of particular interest to miners are those dealing with the inhalation of particles of dust. A table of comparative mortality from lung diseases, for England, shows coal miners to be more free from this trouble than any of the other employments given, as, for instance, carpenters, bakers, plumbers, cotton manufacturers, etc. On the other hand, Cornish miners who work in the tin mines of Cornwall have a greater mortality than any of the other classes mentioned, or almost three times the average of all males in England and Wales, while coal miners are considerably below the average. Quarrymen in stone and slate are intermediate between coal and tin miners and are slightly above the average. The book treats very fully on lead poisoning in all of its phases, and this will be of particular interest to lead miners and workers about metallurgical establishments. The language of the book is clear and entirely free from medical technology, so that it can be easily understood, and it should prove a valuable assistant and guide to all those who aim to lessen the dangers surrounding themselves in their employment.

PERSONALS.

H. H. Brady, Jr., formerly purchasing agent of the Temple Iron Co., has severed his connection with that company and connected himself with the New Mexico Railway & Coal Co.

Charles P. Turner, M. E., who has been connected with The International Correspondence Schools, Scranton, Pa., since 1895, has resigned to accept a position with the Garrett-Cromwell Engineering Co., Cleveland, Ohio.

The following appointments have recently been made in connection with the Temple Iron Co., Scranton, Pa.: Geo. F. Baer, president; A. F. Law, secretary and treasurer; S. P. Thorne, general manager; A. C. Twitchell, purchasing agent.

Mr. H. T. Newcomb has resigned the position of Chief of the Division of Agriculture in the U. S. Census Office, and will hereafter have full charge of the news and editorial columns of the Railway World. His address will be 137 South Fifth Street, Philadelphia.

W. S. Gresley, Mining Engineer, who for some years was connected with the W. L. Scott coal interests, and more recently managing the practical work of the Youghiogheny River Coal Co. for the W. L. Scott estate, sailed with his family for England on April 17. Mr. Gresley proposes to take up professional work again in Great Britain.

Samuel R. Morgan, the well-known mine foreman of the Lehigh & Wilkes-Barre collieries, tendered his resignation last week. Mr. Morgan accepted the position of inside mine superin-

tendent of all the lower D. & H. collieries. For thirty years he was at the head of the L. & W.-B. Coal Co. mines as inside foreman, and is one of the best-posted mining men in the State.

Mr. W. A. Lathrop, general superintendent of the Lehigh Valley Coal Co., with headquarters at Wilkes-Barre, Pa., has resigned to accept the position of general manager of the Webster Coal & Coke Co. The latter company purchased the property of John C. Scott & Sons, together with several other properties some time ago, and in addition, owns large tracts of undeveloped coal lands in Cambria and Blair counties, Pennsylvania. They have also recently purchased all the interests of the Mitchell Coal & Coke Co., which materially adds to the present large output of their mines and coke plants.

The following appointments have been made in connection with the change in management of the Pennsylvania Coal Co., Scranton, Pa.: Capt. W. A. May, general manager Hillside Coal & Iron Co., Pennsylvania Coal Co., and N. Y. Susquehanna & Western Coal Co. Wm. M. Inglis, superintendent Hillside Coal & Iron Co., and N. Y. Susquehanna & Western Coal Co. E. D. Caryl, general coal inspector Pennsylvania Coal Co., N. Y. Susquehanna & Western Coal Co., and the Hillside Coal Co. H. E. R. Yewens, mining engineer, Hillside Coal & Iron Co. H. J. McCormick, land agent Hillside Coal & Iron Co. Sidney Williams, superintendent Pennsylvania Coal Co. Alexander Bryden, mining engineer, Pennsylvania Coal Co. E. M. Beyea, land agent, Pennsylvania Coal Co.

At the first meeting of the directors of the United States Steel Corporation the following announcement was made of officers: President, Charles M. Schwab, president of the Carnegie Co.; First Vice-President, James Gayley, also of the Carnegie Co.; Second Vice-President, W. R. Walker, metallurgical engineer of the American Steel & Wire Co.; Third Vice-President, W. P. Palmer, president of the American Steel & Wire Co.; Treasurer, Arthur T. Luke; Secretary, Richard Trimble, secretary of the Federal Steel Co. Judge E. H. Gary, of the Federal Steel Co., is chairman of the executive committee, and Robert Bacon, of J. P. Morgan & Co., of the finance committee. The policy of the corporation is announced to leave each constituent company with its own set of officers, but subject to supervision of the corporation's officers in New York City. The first vice-president will have charge of the mines and wharves of all the companies, the second vice-president will superintend economical operations, and the third vice-president will have charge of sales.

OBITUARY.

RICHARD P. ROTHWELL.

Mr. Richard Pennfather Rothwell, editor of the Engineering and Mining Journal, died at his residence in New York City on the 17th ult., after five week's illness. Mr. Rothwell was born in Ingersoll, Ontario, in 1837, educated at Trinity College, Toronto, and after that took a course in civil engineering at Rensselaer Polytechnic Institute, Troy, N. Y.; later he took courses in mining engineering in French and German colleges. He returned to America in 1864 and located at Wilkes-Barre, Pa., as a mining engineer. In 1873 he removed to New York City, where he became editor of the Engineering and Mining Journal, which position he held until the time of his death. Several years ago the ownership of the Engineering and Mining Journal was merged into the Scientific Publishing Co., of which Mr. Rothwell was president. While located in Wilkes-Barre he was one of the organizers of the American Institute of Mining Engineers, and in 1871 and 1882 he served as president of that society. Mr. Rothwell was one of the most widely known mining engineers in America. He was a forceful writer on engineering subjects, and was the author of a number of important papers read before the American Institute of Mining Engineers. Besides membership in the American Institute of Mining Engineers, Mr. Rothwell held active and honorary membership in several foreign scientific societies, and was a member of the Engineers', Lotus, Reform, Hardware, Larchmont Yacht, and New York Press Clubs.

JAMES I. BLAKESLEE.

James I. Blakeslee, a former associate of Asa Packer in the construction of the Lehigh Valley R. R., and a director of the road from its inception to the passage of the Wilbur regime, died at his home in Mauch Chunk, Pa., March 31, 1900, at the age of 86. Mr. Blakeslee was born in Susquehanna County, Pa., on February 10, 1815. He entered the service of the Lehigh Valley Railroad as conductor in September, 1855, and retained that position until 1863, when he became superintendent of the Lehigh & Mahanoy Road. He retained that place after the road became the Mahanoy Division of the Lehigh Valley Railroad until 1880, when he was made superintendent of the coal branches of the Lehigh Valley System. He was also from 1870 the president of the Montrose Railway Co.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided.

All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith.

The editor is not responsible for views expressed by correspondents in this Department.

Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution.

Questions on subjects not directly connected with mining will not be published.

Fireclay Wanted.

Editor Mines and Minerals:

SIR:—Can any of the readers of MINES AND MINERALS tell me if good fireclay is found in Tioga or Bradford counties, Pennsylvania.
T. C.

Temperatures of Rocks.

Editor Mines and Minerals:

SIR:—Can any of your readers give me information with regard to the temperatures of the rocks and of the working places in any of the deep mines of the Lake Superior district.
Longton Staffs, England. E. P. TURNER.

Haulage.

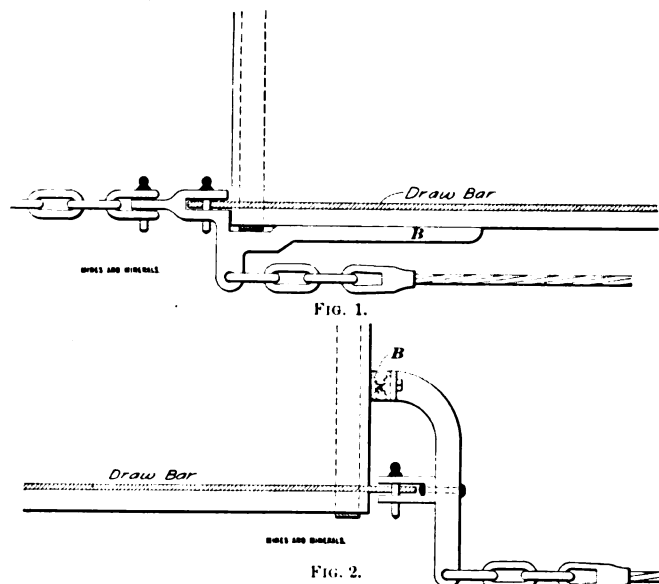
Editor Mines and Minerals:

SIR:—I notice in March issue a plan of the Windber mine, by Mr. J. S. Cunningham, M. E. I would like to ask Mr. Cunningham how he hauls his coal out of the intake side of No. 2 R. heading from rooms Nos. 1, 2, 3, 4, 5, and 6, without the use of a door.
W. J. E.

Belsena Mills, Pa.

Editor Mines and Minerals:

SIR:—In answer to an inquiry in MINES AND MINERALS for March, page 357, under Rope Haulage, for a hitch to make the rope sheave on an incline, I inclose too very rough sketches. Fig. 1 is intended to be put on the front end of the rear car; the tail piece B



being forked to prevent any lateral motion. Fig. 2 is used on the rear end of the last car, the timber B extending clear across the car. With these hitches the rope may be lowered to catch any height of sheave. Fig. 1 is best for heavy trips.

Sequachie College, Tenn.

W. H. FINLEY.

Illuminating Oil for Mines.

Editor Mines and Minerals:

SIR:—I would call your attention to a by-product of petroleum oil, a white paraffin wax, that was placed on the market some years ago under the name of "sunshine." This oil had very desirable properties in regards to light, and cleanliness, and was free from dirt and smoke. Unfortunately it was hard and dry at a very low temperature, and could be used only in specially constructed lamps. It also took too much time to fill the lamp, and it was wasteful; hence it fell into disuse.

The high-grade headlight oil is a good burning oil, but requires too high a temperature for the mines. Now by taking one part of paraffin wax and two parts of the best headlight oil, and mixing them by raising the temperature of both a little we have an oil that is hard to be beat for cheapness, brilliancy, freedom from smoke, or crusts on top of wick in safety lamp, and in sensitiveness. It is the most sensitive oil that I have had the pleasure of burning.

I bring these oils to about the temperature of the hand; having no thermometer to work with.

Johnstown, Pa.

JOHN RETALLACK.

Arrangement of Shaft Bottom.

Editor Mines and Minerals:

SIR:—Replying to the inquiry of J. F. Healy in the April issue of MINES AND MINERALS, under the heading, "Arrangement of Shaft Bottoms," would say, that as we understand the question, we are at liberty to assume any direction of loading tracks at the surface, and also any direction of main haulage roads at the shaft bottom, the surface pitching 10% west, while the seam pitches 5% west. An output of 2,000 tons in 10 hours, with wagons loading 2 tons each, would necessitate 100 hoists per hour, or say, making some allowance for delay, 30 or 35 seconds per hoist. At a depth of 400 feet this would require an average hoisting speed of, say 25 feet per second, leaving 15 or 20 seconds for change of cars at top and bottom. This would form the basis of the figures for size of engine required. We would suggest also that there is a good opportunity to arrange the direction of the haulage roads below, since it is desired to load upon one side of the shaft only, in such a manner as to give a good grade toward the shaft. This grade should be about 1.5%. The same opportunity is also afforded at the surface to allow a good grade for the loading tracks passing over the scales. We would suggest a grade of 2% for 100 feet upon each side of the scales to facilitate the quick starting and easy movement of the cars over the scales. The grade for the empties above this should be, say 1.5%, while the grade for the loads below the scales may be 1.5% for a short distance, and should then reduce to 1%, and gradually fall to a level. By arranging the direction of the main haulage roads you can provide for the grade required.

J. T. B.

Endless Rope Haulage.

Editor Mines and Minerals:

SIR:—I have just received the March issue of MINES AND MINERALS and am interested in R. W. P.'s question and C. E. Bowron's answer. Between the years 1878 and 1882 I was an apprentice with the Dixon and Marshall firm of civil and mining engineers, Glasgow, Scotland. Mr. Dixon was also the Managing Director of the Bart and Hamilton Palace collieries. In the Bart colliery I put an endless rope haulage—there were two or three haulages in the same pit—in which the ropes were cut and the rods moved forward as each set of new stoops was ready to receive the rope. The grades were irregular. The V clip was used there on the side of the car, a little forward of the center, with great success. I never saw an endless haulage work smoother. The rope was always kept close up to the workmen, who pushed their loads out and onto the rope and took the next empty off that came along. At the sheaves the rail was a curved box or channel rail which gave the car considerable latitude going round the curve which it did without being detached from the rope. There were some rather irregular grades in the Bart colliery, and I never knew of any trouble from the rope coming out of the V clip. There was always considerable "bag" in the rope between cars, which of course were hitched on singly. When the car started down a grade the V clip simply changed its position and from the act of pulling the car it changed to holding the car back. I would have adopted the Bart colliery plan here if it had been possible to have the curves all in one direction, as in Bart colliery.

W. D. L. HARDIE.

Lethbridge, Alta, Can.

Dredging for Gold.

Editor Mines and Minerals:

SIR:—Some time since you were kind enough to publish an article for us relative to "Dredging for Gold," to which our friend Postlethwaite, of the Risdon Co., takes exceptions. Now we had no desire to criticise any particular dredge; what we attempted to do was to furnish information that would be valuable to the man who has a gold proposition, and who desires information on how to work it; and we are certain we accomplished the desired result, for we have had many letters complimenting us for the original manner in which we went at the subject, and these letters came from men who have been mining for gold all their lives. One man stated to us that had he not had an experience dating over a long period of years, and knew what we said in the article was true and right, and had he not been able to secure such infor-

mation other than to pay for it, he would cheerfully have given \$500.00 for the information. Other inquiries ask for more information, etc. The information given in that article was just as it was seen by our engineers, who have covered every foot of ground mentioned in the article, and much more besides.

At the time our engineer was up the Feather River, in California, there were only 7 dredges there, and they were just as described in our article, and are there today, for any one to see.

Any person, whether mechanically inclined or not, has sense enough to know that light machinery cannot do heavy work, and we think if you will correspond with a few persons who have, or do now, own dredging machinery, you will find that they have spent a few thousand dollars finding this out.

As to what Mr. Postlethwaite says about the New Zealand dredges: He would try and make one believe that the New Zealand dredges were just as far improved as it was possible for them to be, and that all American builders should make their dredges accordingly. Such is not the case, however, for the gold placer proposition in this country is entirely different from that in New Zealand, and machinery has to be built to work it and not the ground in New Zealand or any other place. We have been here all our lives and building steam shovels and dredges for 30 years or more.

Another thing: he does not agree with us that there is plenty of 25c. ground in the West. We know there is, for our engineers have found it out by a close study of the subject for quite a number of years.

Yours truly,

The Vulcan Iron Works Co.,
S. S. Patterson,
Advertising Manager.

Wind Pressures.

Editor Mines and Minerals:

SIR:—I have searched in vain for satisfactory tables giving the pressures in pounds per square foot corresponding to different wind velocities. Where can I get them? J. L. G.

Troy, N. Y.

This question can be best answered by quoting the following extract from a bulletin of the United States Weather Bureau, by Prof. C. F. Marvin, and entitled Anemometry:

Pressure of Wind.—It sometimes becomes desirable to know the pressure exerted by the wind upon a surface exposed at right angles to the wind's direction. For this purpose flat plates or cylinders or spheres may be arranged with various spring and recording mechanisms, so that the wind pressure against such surfaces will be indicated and recorded by the amount of deflection produced in the spring. Such records, owing to their extremely changeable character and the difficulty of securing accuracy, have never proved very satisfactory, and such instruments are very little used.

Relation of wind velocity and pressure.—The relation between mean pressure of the wind against exposed surfaces and the corresponding wind velocity has never been worked out with entire satisfaction. Nevertheless, rather better results can be obtained by using such facts as are known than to attempt to measure the wind pressure directly. Experiments were made by this Bureau to determine the relation between wind velocities and pressures for certain limited conditions by exposing squarely against the wind variously sized plates of from four to nine square feet of surface. The deflection produced in springs of known strength by the pressure was continuously recorded by a pencil marking upon a revolving cylinder of paper. At the same time and on the same sheet of paper was also electrically recorded the velocity of the wind as indicated by an anemometer exposed near the pressure plate.

From these experiments, it is found that wind pressures are not so great as generally computed heretofore, and are quite accurately given by the following equation:

$$P = .0040 \frac{B}{30} S V^2.$$

P = pressure, in pounds avoirdupois;

S = surface in square feet;

V = corrected velocity of wind, in miles per hour;

B = height of barometer, in inches.

For stations near the sea level, where the barometric pressure does not differ much from 30 inches, the ratio $\frac{B}{30}$ need not be considered. For elevated stations, however, with barometric pressures ranging one or more inches below 30 inches, the effect of this must be considered.

While the formulas herewith presented give results, it is believed, more nearly correct than before obtained, yet, owing to the great difficulty of making accurate experiments at high velocities, these adopted values can be regarded as only approximate.

Great dependence cannot be placed in these values for indicated velocities beyond 50 or 60 miles per hour, as thus far direct experiments have not been made at the higher velocities, though it is probable the corrected values are throughout much more accurate than values computed from older formulas and uncorrected wind velocities.

TABLE OF WIND PRESSURES (POUNDS PER SQUARE FOOT).

Indicated Velocity.	+ 0	- 1	+ 2	+ 3	+ 4	+ 5	+ 6	+ 7	+ 8	+ 9
0						.104	.144	.190	.243	.303
10	.369	.433	.511	.596	.666	.762	.853	.949	1.05	1.16
20	1.27	1.38	1.50	1.63	1.76	1.90	2.04	2.19	2.34	2.48
30	2.64	2.81	2.98	3.14	3.32	3.50	3.67	3.87	4.04	4.24
40	4.41	4.64	4.84	5.07	5.27	5.51	5.72	5.93	6.18	6.40
50	6.66	6.89	7.12	7.40	7.64	7.88	8.14	8.43	8.69	8.95
60	9.22	9.49	9.76	10.1	10.4	10.6	10.9	11.2	11.6	11.9
70	12.2	12.5	12.8	13.1	13.5	13.8	14.1	14.4	14.8	15.1
80	15.5	15.8	16.2	16.5	16.9	17.3	17.6	18.0	18.4	18.8
90	19.2									

The Herzler & Henninger Mining Machine.

The mining machine here illustrated is manufactured by the Herzler & Henninger Machine Works, Belleville, Ill., and during the last three years 300 of these machines have been put into successful operation, a number of them having been sent to Nova Scotia, and wherever sold they seem to be giving good satisfaction.

The machine was designed, patented and is built by Messrs. John Herzler, Henry Henninger and Wm. Fenner, all of whom are experienced machine builders. They have made a careful study of mining machines and the location of their works in a region where these machines are largely used has given them exceptional facilities for studying such machines in actual operation and for observing the difficulties and weak points of all types of mining machines. Many of these they think they have overcome in the machine here illustrated. It has been their aim to build a simple and durable machine and one with the fewest possible working parts, which is always a desirable element in any machine intended for use in the coal mine. The machine is also constructed so that it does not require a skilled workman to operate it—another very important point in a mining machine. Its efficiency has proven high and it has been found to be an economical user of air, while the repair cost is low, due to the fact that only the best materials have been used in the construction of the machine.

The cylinder, slide valve and wheels are made of gray iron, the sleeve or front head of steel, the piston of close grained steel



accurately finished, the pick-socket of steel, and the bushing or guide for the piston rod of bronze. No key is required to hold the socket and pick in place. The machine can be easily balanced by loosening one nut and slipping the trunnion backward or forward in the slot cast in the side of the cylinder, thus obviating all handling of cumbersome weights as is sometimes done. There are no leather or rubber cushions in the cylinder, but the air imprisoned within the cylinder forms a cushion which prevents the piston from striking the heads. The piston rod can be packed like an engine piston rod from the outside and the bushing can be replaced without taking the machine apart. The regulator is very simple and can be easily adjusted so that the pick will strike either a long heavy blow or a short light blow. It will undermine to a depth of 6 feet and will cut to a height of 20 inches on the face. The weight of the machine is 850 lbs., and the length from point of pick to the rear of the handle is 8 feet. The width is 20 inches and the height over all, 18 inches. The operator can swing the machine and direct the blow with one hand and can work either right- or left-handed.

Messrs. Herzler & Henninger in addition to this mining machine make a truck for transporting it, also a rotary coal drill, ventilating fans, center crank engines, mine cars, and other varieties of mine equipment.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes, and to mention the numbers of the questions when so doing.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for May.

QUES. 676.—*Inversion of a Vein*.—What is meant by inversion of a vein, and how is the fact of its inversion determined practically?

QUES. 677.—*Size and Inclination of Screens*.—Give the proper size and inclination of lump coal screens for bituminous coal, and state how the inclination should be modified where the coal is wet. Give the size and inclination of nut coal screens for bituminous coal. How is this inclination affected in the case of shaking screens? What is the proper inclination for a revolving nut screen?

QUES. 678.—*Self-Acting Inclines in Steep Pitching Seams*.—Explain the operation of the self-acting incline for lowering material from the working face to the gangway in a steep pitching seam where for some reason it is desired to use inclines instead of chutes.

QUES. 679.—*Size of Shaft Pillars*.—(a) What size of pillar should be left for the support of a shaft 100 yards in depth, when the thickness of the seam is 5 feet? The coal is hard but the bottom is soft and heaves readily. The roof is a hard slate. (b) What size of pillar should be left when the thickness of the seam is 10 feet, the other conditions remaining the same?

QUES. 680.—*Water-Gauge Readings at the Top and Bottom of Shaft*. If the water gauge showed a reading of 3 inches at the fan drift at the top of a shaft, while the reading taken between the intake and return airways at the foot of the shaft was $3\frac{1}{2}$ inches, what would this indicate in reference to the power concerned in the movement of the air current? (b) If the fan was making 50 revolutions per minute when the above readings were taken, and its speed be now increased to 75 revolutions per minute, what readings would you then expect to obtain at each of these points respectively, at the top and the bottom of the shaft? (c) In what proportion would the quantity of air in circulation be increased in this case?

QUES. 681.—*Drilling Prospect Holes*.—In a mountainous region where the general inclination of the strata is 60° , it is desired to drive a drainage tunnel into the side hill to intersect the main slope of a mine at a point 1,500 yards down the slope from its mouth. Before starting the work, however, it is proposed to prospect the strata by drilling in order to ascertain approximately the probable cost of driving the tunnel. Where should the necessary hole or holes be drilled to obtain this inclination? Would it be practicable to drill a nearly horizontal hole across the strata at the proposed site of the tunnel, and if not, why?

QUES. 682.—*Size of Mine Timber*.—If timber 6 inches in diameter has been used successfully for the collars or cross-beams in entries 8 feet wide, what should be the diameter of the cross-beams in the same mine for partings, where the clear width of the road is 14 feet? If 6-inch timber is used at the working face where the

posts are $4\frac{1}{2}$ feet in length, what should be the diameter of the posts on the main roadways of the mine where the height is 6 feet in the clear?

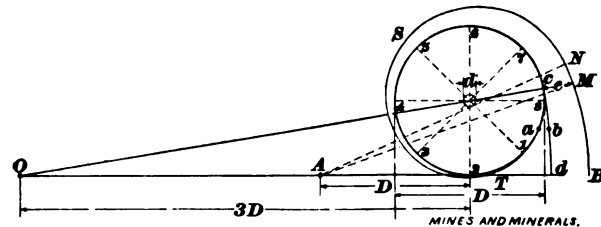
QUES. 683.—*Surveying With a Vernier Compass*.—Explain how you would establish a reliable magnetic meridian where iron is used upon the roadways, supposing that you have a vernier compass at your disposal.

Answers to Questions Which Appeared in the March and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 648.—*Form of Fan Casing*.—Describe the best form of fan casing and state how you would proceed to lay out and construct the same.

ANS.—I consider the Schiele casing the best form of fan casing. This consists of a spiral casing commencing with a small clearance at the end of the fan blade and gradually increasing all around the circumference of the fan to the chimney. I would make the width of the chimney equal to the width of the fan casing; and the depth of the chimney [at its base] equal to one-half of the diameter of the fan; and the diameter of the intake opening at the center of the fan equal to one-half of the diameter of the fan. [This last should be modified, so as to refer to fans receiving air upon one or both sides.]

In order to lay out and construct this casing prepare a level piece of ground or a platform on trestles to hold one side of the fan casing, and lay down plank upon this platform, enough to form one side of the casing. Select a center, and from that center, with a sweep and pencil describe a circle having a diameter equal to one-half the diameter of the fan for the central or intake opening. From the same center describe another smaller circle whose circumference will be equal to one-half of the diameter of the fan; and on the circumference of this circle drive nails 3 or 4 inches apart, leaving the nails partly driven. Fasten a tape line to the nail on line from the center of the fan to the point



of least clearance or the commencement of the spiral, and wrap the tape line around the circle, on the nails, in the direction opposite to that in which the fan revolves, for one revolution nearly, and extend the tape to the point where the spiral commences. Hold the pencil to the tape, keeping the latter in tension, and describe the spiral in the direction in which the fan revolves, until a point is reached opposite the point of commencing the spiral. Then, from this point and from the point of commencement lay out the chimney tangent to the spiral at each point. Find this tangent by placing a square at the point of the commencement of the spiral, and one blade being on line to the center of the fan the other blade will be tangent(?) to the spiral. The tape unwinds from the nails, as you describe the spiral, and thus gradually increases the radius until the chimney is reached, when it will have increased one-half of the diameter of the fan.

Finally, saw out the two sides of the casing according to the lines thus drawn and construct a frame to suit; saw out one or both central or intake openings as desired.

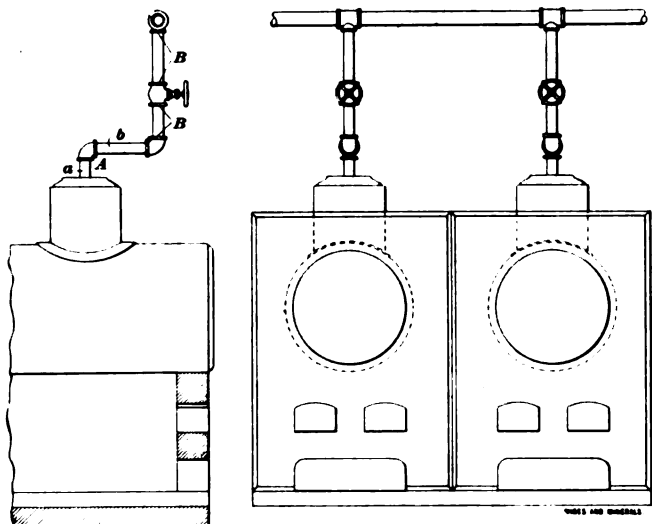
TALMADGE BLASS, Vintondale, Pa.

Second Prize.—None.

[We would suggest that our correspondent's answer could be improved in two essential points: (a) The spiral casing should commence at a distance from the cut-off c (Fig. 1) or base of the chimney, not less than the distance between two consecutive blade tips. If expansion begins at the cut-off the spiral space surrounding the fan is left open at both ends, which interferes with the continuous flow of the air around the fan in the direction in which the fan revolves, and results in vibration and shock or pounding, in the fan; (b) The amount of expansion should be calculated so that the area at the cut-off will be such that the velocity of the current will not be less than the tangential velocity of the blade tips. For the formulas and methods used for this purpose, see page 105, MINES AND MINERALS, October, 1899.]

QUES. 649.—*Boiler Connections, Allowance for Expansion*.—In setting a nest of boilers and making the necessary connections with the main steam pipe, describe how you would provide for the expansion and contraction of the steam line.

Ans.—In order to provide for the expansion and contraction of a steam line furnishing steam to a nest of boilers, each boiler should be provided with a swing-arm connection as shown in side and end views in the accompanying figure. A short nipple *a* is screwed into the steam dome of the boiler, having an elbow upon its upper end. The swing arm *b* is made of any required length from 18 inches to 6 or 8 feet, and is supplied with an elbow and a nipple. Above this is placed a globe valve and another nipple connecting the valve with the T in the main steam line above each boiler. This T is supplied with flanged unions so that the several lengths of pipe between the boilers can be put in place without screwing the pipes. This method will allow of a perfect expansion or contraction of the pipe line between the boilers, since the swing arm admits of a longitudinal movement of the



pipe by a slight motion in the joints at *A* and *B B*. At the end of the pipe line, if necessary, expansion should be allowed for by using four elbows, two nipples, and a short piece of pipe [or an expansion or slip joint may be used at this point], thereby providing for a free movement of the pipe longitudinally.

J. E. JONES, Centerville, Iowa.

Second Prize.—A. B. JESSUP, Centralia, Pa.

Ques. 860.—Roasting Silver Ores.—Describe briefly the roasting of an argentiferous ore composed of sulphates, arsenates, and antimonates.

Ans.—The ore having been previously crushed, to pass through a 40-mesh screen, or finer, and screened and dried, is then roasted in a reverberatory, Stetefeldt vertical shaft, or a Brückner revolving cylinder furnace. This roasting takes from 6 to 8 hours, or even longer, depending upon the character of the ore. During the first part of the roasting the ore is treated alone, being introduced into the cooler part of the furnace, and brought gradually to a full heat by being moved forward. During this first period most of the sulphur, arsenic, and antimony passes off in dense clouds [and later the full heat reduces the sulphates, arsenates and antimonates, and expels their volatile portions]. When the sulphur, arsenic, and antimony have passed off, as can be seen by the diminution of the volume and density of the fumes, common salt is added, and the roasting continued; the amount of salt added being in proportion to the richness of the ore under treatment. The action of the salt is to convert the silver into silver chloride ($AgCl$). It is not added earlier in the process, as silver chloride is slightly volatile and there would result a loss of silver.

C. DRINKWATER WRAY, Lillooet, B. C., Canada.

Second Prize—None.

Ques. 861.—Examining for Gas.—If you were examining the condition of the main return airway in a very gaseous mine, (a) What kind of lamp and flame would you use? (b) Would you travel with or against the current? Explain fully.

Ans.—I consider the Ashworth-Hepplewhite-Gray lamp the best to use for the purpose named, for the following reasons: (1) The air enters the lamp below the flame, thereby affording the best conditions for producing a good flame cap. (2) The lamp can be made to draw its air from above when it is desired to test for gas close to the roof by closing the air ports at the bottom of the standards of the lamp. (3) The conical shape of the glass chimney assists the upward diffusion of the light, making the inspection of the roof easier, while the same shape in the gauze chimney surmounting the glass one renders the lamp more secure and better able to resist explosions of gas within the lamp. This lamp will detect as low as 2 per cent. of gas in the current.

I would lower the flame of the lamp to a small size when testing. It is always better to adopt a uniform size of flame in order to obtain uniform results in testing for gas. I would travel with the current so as not to unduly accelerate the force of the air impinging on the gauze of the lamp [since the effective velocity of the air current with respect to the lamp is always equal to the velocity of the air in the airway, increased or diminished by the velocity with which the lamp is moving, according as it moves against or with the current]. For example, if a lamp is carried with a velocity of 5 feet per second against an air current having a velocity of 20 feet per second, by a man walking a little more than 3 miles per hour, the effective velocity of the current with respect to the lamp is $20 + 5 = 25$ feet per second. [When walking at the same pace in the direction in which the current is moving, the effective velocity of the air with respect to the lamp is $20 - 5 = 15$ feet per second.] Again, the lamp may be carelessly swung backward and forward by the man who carries it, and this again may increase the effective velocity to, say 45 feet per second. Now, the air being highly charged with marsh gas few lamps would be safe under such conditions. [When traveling with the air current one would first encounter a body of gas at the place where it was being produced, and could examine this place more safely since a ready escape is always at hand to fresh air; but when traveling against the current one might be easily entrapped in a body of gas from which he would have no escape, and he would also have no knowledge as to the locality from which this gas issued.] THOS. O'BRIEN, LaSalle, Ill.

Second Prize.—GEO. MCPHAIL, Southwest, Pa.

Ques. 862.—Setting Post Timber at the Face.—Explain fully how you would set a post at the face of a breast in a flat seam, 5 feet thick, under 250 feet of cover, the roof and floor being hard. Give size and kind of timber you prefer.

Ans.—It is of prime importance that the timber be first cut to a suitable length and squared at both ends, and that a good thick cap piece be placed on top of the post so that when the weight of the overlying strata commences to bear on the timber the head of the post will become embedded in the cap, which will act as a hoop to bind the top of the post together and prevent its splitting. The timber used should be long grained and elastic, without being extremely heavy to handle; as for example, pine, fir, hemlock, or other like timber combining a fair amount of strength with elasticity, which will permit them to bend before breaking. Due warning is thereby given to the miner enabling him to reach a place of safety before a fall of roof takes place.

It should be borne in mind in setting mine timber, that it is not the purpose of the timber to support the entire weight of strata above, but rather to hold any loose pieces of rock in place and prevent them from falling and injuring the workmen. [The arching over of the strata can always be depended upon for supporting a large portion of the weight.] The floor and roof strata being hard, provision must be made so that the timber will take the weight or roof pressure gradually. [When this is done, instead of the entire pressure coming upon the timber, a portion of the weight arches over.] In order to accomplish this a soft padding or mound of dirt or slack should be made upon which to set the post; when the weight comes on, this dirt yields, and the timber takes the weight gradually [or the end of the post is sometimes tapered for a short distance up from its foot, and the burring or fuzzing of the tapered end as the pressure comes on the timber, causes the post to take the weight gradually]. The foot of the post (small end) is placed upon the mound of dirt, a foot-board or sill being sometimes used, and the cap being put in position above it against the roof, the timber is driven to its place in a perpendicular position.

WM. MCCUSKER, Mt. Pleasant, Pa.

Second Prize.—JOS. QUIGLEY, Broad Cove Mine, Cape Breton, N. S.

Ques. 863.—High-Tension and Low-Tension Exploders.—What is the essential difference between high- and low-tension exploders? Explain their relative advantages and disadvantages.

Ans.—The essential difference between high- and low-tension exploders consists in the arrangement of the wires for firing. In the high-tension exploder the wires have their bare ends close to one another in the cartridge, but do not touch each other, the current jumping across the intermediate space and producing a spark that ignites the fulminate and causes the explosion. In the low-tension exploder the ends of the wires are farther apart and the space between them is bridged by a fine platinum wire, which is rendered incandescent by the current and ignites the fulminate, thereby causing the detonation. The energy developed in exploding high-tension exploders is greater, and the chance of misfires or imperfect shots is lessened; while on the other hand the number of shots it is possible to fire at one time is less for the same battery than when low-tension exploders are used. The advantages obtained by the use of high-tension exploders are then more perfect detonation and less risk of misfires. The disad-

vantage is that with the same battery the number of shots fired at one time is less. [There is also greater danger of sparking of the wires, and ignition of firedamp in gaseous mines.]

C. D. WRAY, Lillooet, B. C., Canada.

Second Prize.—None.

Correction.—Attention has been called to an error in the reading of question 664, in the March issue, and the question is therefore repeated, and remains open. It should read as follows:

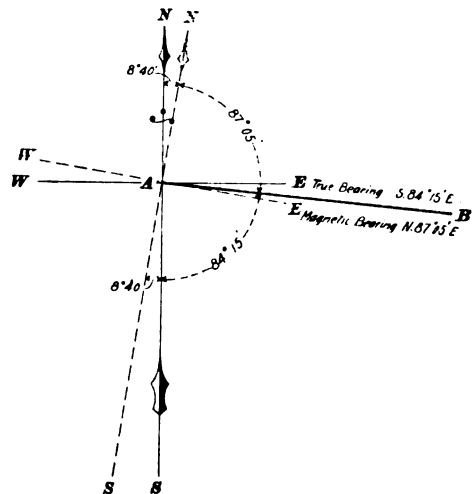
Ques. 664.—*Locating Error in a Survey.*—Following are notes of a surface survey enclosing a plat of ground.

Sta.	Angle.	Distance (Feet).	Sta.	Remarks.
1	R 102° 30'	250	2	B. S. = Sta. 5.
2	R 54° 55'	500	3	
3	R 35° 25'	825	4	
4	R 73° 50'	242	5	
5	R 98° 20'	1,383	1	

As this survey does not close there is evidently an error in the work or notes. Explain how you would proceed to locate this error in the quickest manner possible, assuming that the work has been done carefully throughout, and that therefore the trouble arises from a single error, at some point of the survey, instead of several errors.

Ques. 666.—*To Calculate Magnetic Bearing.*—The direction of certain chambers is given upon a mine map as S 84° 15' E. If the declination of the needle (magnetic variation) is 8° 40' E, explain how you would proceed to give the proper sights for these chambers, with only a plain compass at your command. In other words, calculate the magnetic bearing of the sight lines of these chambers.

Ans.—The safest method of converting true bearings into magnetic bearings or vice versa, is by first reducing both sets of bearings to their corresponding azimuths. The azimuths of the true bearings will be referred to the true meridian, while the azimuths of the magnetic bearings are referred to the magnetic meridian. The azimuth of any line is the angle that line makes with the true or assumed meridian, such angle being measured around to the right from the north point of said meridian as zero. In this case since the magnetic declination is 8° 40' E, the true azimuth of the magnetic meridian will be 8° 40', and, therefore, to convert the true azimuths into magnetic azimuths, we



must subtract 8° 40' from the true azimuth in each case. The true bearing of the chambers being S 84° 15' E, the corresponding azimuth is 180° - 84° 15' = 95° 45'. Subtracting 8° 40' from this azimuth to obtain the magnetic azimuth of the chambers, we have 95° 45' - 8° 40' = 87° 05'. Therefore, the magnetic bearing of the chambers is N 87° 05' E, which is the reading for the sight lines of these chambers when using a plain compass [We introduce Mr. Simons sketch illustrating this question.]

WILLIAM T. MACDONALD, Los Angeles, Cal.

Second Prize.—Theodore Simons, Spokane, Wash.

Ques. 665.—*Brakes vs. Sprags for Mine Cars.*—Which do you prefer in the equipment of mine cars, brakes or sprags? State the reason for your choice.

Ans.—The preference for equipping mine cars with sprags or brakes should be determined by the consideration of the conditions prevailing at the mine where the cars are to be used, as regards the character of the seam and the grades of the haulage roads. (a) Where the seam is gently rolling, or where the local pitches are neither long nor heavy, it would be a wholly unnecessary outlay to equip mine cars with brakes [and would entail a large expenditure for repairs and renewal of rolling stock], besides adding an unnecessary load to the cars, and requiring an increase of power for the haulage. In such a case where the demand for brakes is only occasional and local, sprags can be used to better

advantage and with a great saving of expense [especially when the cars are small and the loads light]. (b) But in pitching seams such as are often found in the bituminous districts of Pennsylvania and other places, it would be madness to attempt to obtain the necessary service by the use of sprags. Such conditions [as well as a heavy output, and large cars, in thick and less pitching seams] should determine a decided preference for the equipment of the mine cars with brakes of the most approved kind. I would, therefore, advise the use of brakes whenever the conditions demanded, as a great saving in car wheels and axles is thereby effected. Sprags cause a flattening of the wheels [which results in an increase of the power necessary for haulage, besides creating a greater wear and tear upon the entire system. Many seemingly unavoidable accidents have occurred in the use of sprags, owing to the inability of the driver or spragger, as the case may be, to insert the sprags in the wheels of the cars, or because the sprags were not at hand at the place where needed. Moreover, a trip of cars must be stopped at the foot of the grade in order to take out the sprags, while a brake can be released at any time without stopping the cars. This is a great argument in favor of brakes when the grades in the haulage road are variable, and the momentum acquired in descending one grade assists the car to ascend another grade].

R. PARDOX, Dunlo, Pa.

Second Prize.—R. ZERUBABLE VIRGIN, Punxsutawney, Pa.

Ques. 667.—*Sizes of Suction and Discharge Pipes of a Pump.*—What should be the diameters of the suction and discharge pipes, respectively, for a pump delivering 5,000 gallons of water per hour?

Ans.—Allowing a velocity of 200 feet per minute in the suction pipe and 400 feet per minute in the delivery pipe, as is customary in practice, and letting

d_1 = the diameter of the suction pipe (inches),
 d_2 = the diameter of the delivery pipe (inches),
 G = the water delivered (gal. per min.),

we have for the diameters of the suction and delivery pipes, respectively,

$$d_1 = 4.95 \sqrt{\frac{G}{200}} \text{ or } d_1 = .35 \times \sqrt{G},$$

$$d_2 = 4.95 \sqrt{\frac{G}{400}} \text{ or } d_2 = .25 \times \sqrt{G}.$$

But, in this case the pump is delivering $\frac{5,000}{60} = 83.33$ gal. per min., and substituting this value for G in the above formulas

we have for the suction pipe $d_1 = 4.95 \sqrt{\frac{83.33}{200}} = 4.95 \sqrt{.4167} = 4.95 \times .6455 = 3.195$ in., say 3.2 in.; and for the delivery pipe $d_2 = 4.95 \sqrt{\frac{83.33}{400}} = 4.95 \sqrt{.2083} = 4.95 \times .4564 = 2.259$, say 2.26 in. But since the sizes of pipe in use usually vary by half inches, the size for the suction pipe of this pump should be 3½ inches and that for the delivery pipe 2½ inches.

JOHN STEFLING, Santa Rita, New Mexico.

Second Prize.—H. R. SOMES, Brewster, Mass.

Notes on Scientific Societies and Publications.

The meetings of the society of Chemical Industry will in future be held at the Chemist's Club, No. 108 West 55th St., New York City, and not at the College of Pharmacy as formerly, while the dinners will be served at the Hotel Grenoble.

At a recent meeting of the Canadian Institute of Mining Engineers the following officers were elected: President, Mr. Charles Fergie, Mining Engineer, Westville, N. S.; Vice-Presidents, Mr. R. R. Hedley, Metallurgist, Nelson, B. C., Mr. Graham Fraser, Ironmaster, New Glasgow, N. S., Dr. Frank D. Adams, Geologist, Montreal, Mr. Jas. McArthur, Metallurgist, Sudbury, Ont.; Secretary, Mr. B. T. A. Bell, Editor Canadian Mining Review, Ottawa; Treasurer, Mr. J. Stevenson Brown, Montreal; Council for British Columbia, Mr. J. B. Hobson, M. E., Queanelle, B. C., Mr. W. F. Little, Colliery Manager, Anthracite, N. W. T., Mr. E. B. Kirby, M. E., Rossland, Mr. Bernard MacDonald, M. E., Rossland; For Ontario, Prof. Courtenay DeKalb, M. E., Kingston, Mr. P. Kirkegaard, Mine Manager, Delore, Ont., Major R. G. Leckie, Sudbury, Ont., Mr. R. G. McConnell, Ottawa; For Quebec, Mr. George R. Smith, M. L. A., Mine Manager, Thetford Mines, Que., Mr. James T. McCall, Iron Merchant, Montreal, Que., Mr. Jas. F. Lewis, Sherbrooke, Que., Mr. J. Burley Smith, M. E., Montreal; For Nova Scotia, Mr. R. E. Chambers, M. E., Belle Island, Newfoundland, Mr. D. W. Robb, Mechanical Engineer, Amherst, N. S., Mr. Henry S. Poole, M. A., A. R. S. M., M. E., Halifax, Mr. G. F. McNaughton, Mine Manager, Forest Hill, N. S.

COAL AND MINES OF SOUTH WALES.

Why Welsh Coal Can Withstand Competition and Yet Command a Higher Price—The Difficulties Met in Mining It.

By Hon. A. Howells.*

To treat this subject in its entirety would require a paper of such length that it would tire your patience to listen to it, as well as being very tiring to the person reading it; consequently, I shall confine myself as much as possible to the few main and pertinent facts regarding this child giant of coal production, and especially to that celebrated seam that stands as much above other coals for steam producing as Patti does in the world of song, or as Shakespeare does in the poetic world.

It is perhaps one of the most remarkable freaks of geological production that is known, because, nothing in chemical science could produce a better article for the production of steam (at any cost) than nature has done in this case; its fame is known all over the world where steam is generated, but very few, comparatively speaking, even of those that are handling it every day, know the "whys and wherefores" of its superior qualities for steam producing power.

I was born and raised to young manhood in the immediate vicinity to where this coal is produced, but like the hundreds of thousands of others that are there today, the only answer I could have made regarding the superior quality of the coal would be, "That it was so." I could not have given more reason for it when I first came to this country than can millions of persons today give if asked, "Why does the sun rise each morning in the East?"

When steamboats commenced supplanting sailing vessels, I often read of this wonderful mineral coal, and noticed that it was always selling at from 50 to 60 cents per ton higher than any other British coal, and at nearly double the price of coal in this country, and being a native of that spot, as before mentioned, it raised my curiosity very much, and I often speculated on the fact, trying to make out the "whys and wherefores" but was never satisfied on the main point, so I made up my mind that if I ever paid the "old sod" a visit, the first thing I would do would be to satisfy myself regarding this matter.

Fortunately, or perhaps in some respects unfortunately, I was sent over to that very spot to look after the interests of this country at Cardiff; the next day after my arrival I saw a car load of coal, and finding it to be semianthracite in character I knew it contained a good complement of carbon, so one point was gained, yet that did not disclose the fact of its superior quality for steam purposes, because I knew that the anthracite coal of this country had carbon enough, yet it was not considered a good steam coal; there was nothing left but to get the analysis. In a short time I found several old schoolmates and early friends in positions to give me all the information desired, and when I will read to you the analysis you will see at a glance that which I have before asserted, that it stands as "King" among the other known steam coals of the world.

It analyzes from 86 to 90 per cent. carbon, from 8 to 12 per cent. volatile or combustible matter, from $1\frac{1}{2}$ to 2 per cent. ash, and from $\frac{1}{2}$ to $\frac{3}{4}$ per cent. of sulphur; when I saw that, it was the telltale of its superiority, if it had a greater amount of carbon and some more ash, with less combustible matter, it would degenerate into a poor steam fuel, and indeed this is the very thing that this same seam of coal does, because, for almost ten miles in the western part of the basin it becomes a pure anthracite, consequently it is only used for domestic and melting purposes.

When I commenced keeping house in Cardiff of course I had to buy some coal, and when I was charged \$5 per ton for coal that was mined only fifteen miles distant from the town, and the miners were not paid quite as much per ton as we were paying our miners here, I almost made myself believe that the coal operators of South Wales were "Bloated Coal Barons" sure, and that such a charge for coal was at least second cousin to highway robbery; however, after investigation I found they were like coal operators in this country, those that made a lucky hit made good profit on their investments, while others made nothing, and in some cases fortunes were lost. It is hard for us in this country to conceive why any people that receive from \$2.50 to \$3.50 per ton at the pit mouth for coal should lose money, or why they should not get to be immensely rich in a very few years, especially when no more per ton is paid either to the miner or for royalty, and also the advantage of close proximity (an average of sixteen miles) to the wide and expansive ocean, as well as steady work all through the year—but nevertheless the assertion is true and the reasons for it are as follows:

First, the shafts are very deep, being from 1,000 to 2,300 feet, and to rig up the plant ready for work costs from \$250,000 to

*A paper read before the Ohio Institute of Mining Engineers, Feb. 26, 1901.

\$500,000, because of that depth, and to take out the proper quantity of coal (from 1,000 to 2,000 tons per day) it requires very powerful machinery, the hoisting engines being double cylinders, and each cylinder from 42 to 48 inches in diameter and from 5 to 6 feet in the stroke, the drum from 15 to 20 feet and the sheave wheels the same dimensions, all geared to hoist on first motion, making a trip every $\frac{1}{4}$ of a minute through the day when necessary.

In being lowered into one of those pits you go so fast that the imagination is that you are merely dropping down.

About 100 feet from the hoisting shaft the air and pump shaft is located. The machinery used here is nearly as powerful as the hoisting machinery, and, as our friend Mr. Ed. Haseltine said in his paper that was read at the Winter meeting of 1897, everything is scrupulously clean and in the best of shape.

Regarding Mr. Haseltine's paper, to record what he has done, and considering the very short time in which he had to do it, he must have had his eyes and ears wide open, neither being backward with the tongue in asking questions, and excepting in a couple of instances (of course I do not take into account names of places like Ynis y bwl, etc.) very accurate indeed; however, instead of miners making 75 cents per day it should have been at that time not less than \$1.25 per day. Miners of South Wales are paid on a sliding scale basis; first, when coal is selling at a certain price there is a standard price for mining, the sale of all the coal sold in the district is audited every two months in the presence of the Joint Sliding Scale Committee, and if the auditing shows that the price of the coal has advanced the miners receive a percentage of such advance for the two months following. If it shows a reduced price the mining is reduced in the same proportion.

This was adopted about the year 1874 after a long and ruinous strike, and since that time there has occurred but one serious strike; hence, the miners, generally speaking, are doing well, and consequently are fairly contented and happy.

Just now coal sells at Cardiff higher than ever before, consequently the operators, miners, and all connected with coal mining are reaping a rich harvest, the Transvaal war being the factor in this respect.

The Dowlais Iron Co., before any shipment of coal was made from its Pont y Pridd pit, had expended over \$500,000, taking them (on account of an unusual flow of water for that country) seven years to get its plant in shipping order, the pit being about 2,200 feet in depth.

If a circle of 15 miles had been drawn around our friend Haseltine when he stood at the Pont y Pridd Station, he would have been a member of a community containing about 800,000 people, almost all of whom are dependent upon coal mining, while about 70,000 of them are employees at the coal mines.

This spot on our earth is also remarkable in its production in tonnage of coal considering the small space it occupies.

The trough of the basin runs nearly east and west, raising sharply (in some places) north and south, the extreme length being about 50 miles with an average width of about 17 miles, containing something less than 900 square miles.

Coal from this basin was taken out at a very early date, and having native iron ores in profusion, the making of pig iron, in a crude manner, was commenced about 160 years ago, and for the reason of its mineral it became a great iron-producing center, and so it is today in the production of steel; but its iron and steel industry has become a mere speck when compared with its coal industry, because out of that small space of ground not less than 20,000,000 tons of coal annually have been taken for several years and rapidly increasing until it is now producing about 27,000,000 tons, about 15,000,000 tons of which were shipped from the port of Cardiff in the year 1899, going to every part of the world (excepting this country) where steam is required.

Of necessity these mines have a long life, anywhere from 15 to 30 years, depending on the daily production, and also on the number of acres under lease, which generally is from 500 to 2,000 acres, otherwise it would not pay for the great first outlay required.

Also several working veins are found in the strata (but not all of the same quality) and worked from the same pit, in some cases by driving across the measures and sometimes by sinking deeper, or by making a new bottom for an upper vein, etc.

This coal is all worked on the longwall advancing system (however not from choice but from necessity), hence, the great increase in the cost of producing the coal.

When I made a visit to one of these mines, an old friend of mine being the head of the office officials, at that time the coal was selling at about \$2.75 per ton at the pit's mouth, I said, "David, at the price you get for coal in this country the operators must be getting wealthy on a run," he answered, "Mr. Howells, that is just where you are in error. If I was to tell you that this company has not declared a dividend in the last three years it might surprise you, yet it is only the bare truth." I said, "How is that possible?" "Well," he said, "We have about 1,500 men

in and around the works and the diggers only number about 700, so you see there are about 800 day men. If we could transpose these figures giving us 800 diggers and 700 day men we could make money." That opened my eyes as to the price being exorbitant, and to the fact that if the coal had not been of such a quality as to procure an extra price, very little of it would have been mined, especially by that system of mining, or any other system known to man. I had a talk with others on the same matter and the same facts were reiterated, and also that when coal had to be sold at less than \$2.40 per ton only a very few favored mines could be worked with a profit.

My intention is (some time in the future) to give you a paper on this much mooted and mistaken idea that has been so often under discussion in several meetings of this Institute: the long-wall system—indeed, I might say that it has been so thoroughly threshed from one standpoint that even none of the straw is left, but I venture to say this, that if any operating company in the great majority of the districts in this State, will practice the long-wall advancing system of mining, it will not be long before it will be without a coal mine, and perhaps without money enough to open another one, and will also lose more coal than is now done by the double-entry and room-and-pillar system. But I must leave this until another time, otherwise it will provoke discussion on a side issue and not on the main object of my paper.

We often read in the newspapers what wonderful strides we are making in marketing iron, steel, and coal, and that we are beating Great Britain out of markets that she has always held, being able to undersell the British, etc. I was lately reading a letter sent broadcast over the country by an U. S. Consul (proving no doubt satisfactory to the writer) that now is the time to send our American coal to Europe, for the reason that it could be sold at a less price, and equal in quality to the best Welsh coal, etc. The letter was nothing but a surface talk; looked well on paper and a racy article, but the writer knew as little of the actual conditions of that which he wrote about as a letter from me would be on astronomy or farming; the fact is we are not taking any coal market from Great Britain, and never will; we are merely filling up the gaps and the holes that Great Britain is unable to supply; for instance, when the steam coal of South Wales is selling today at from \$6 to \$6.50 per ton f. o. b., at Cardiff, what do they (operators there) care what American coal will be shipped, and at what price, as long as they have a market for all the coal that they can produce at such a remunerative price, but once they are cut off from having sales for their full production they can very easily strike off a dollar per ton; and if a dollar will not do they can strike off three dollars per ton and then make a profit.

This coal is of a peculiar construction; it has no seams, excepting face slips, and looks very much as if very fine particles of coal were pressed together; and to try and break it with a hammer or some blunt tool will mash it all into fine slack.

But there is a time surely coming, and that within twenty-five years, that Great Britain will not be much of a factor in competition with this country in the coal markets of the world, because at the present rate of production (to say nothing of increasing its capacity) Great Britain will not be able to produce the quantity that is produced at the present time, and especially is this true of the celebrated Welsh steam coal; indeed, I venture to put myself on record that the production of this Welsh coal in twenty-five years from now will be 50% (or more) less than it was for the year 1899, and the tonnage of the entire country much less than at the present time.

Then considering that the consumption of coal increases, and will rapidly increase in the future, the consuming world must look for its necessities somewhere outside of Great Britain, and nowhere else known to civilization today, can that necessity be so well taken care of as by the United States.

This paper was written and expected to have been read at the January, 1900, meeting, and I will only add to it now by saying, that the increase in the consumption of coal makes it more apparent than it did then, that the United States will be called upon to fill up the gaps that Great Britain cannot supply, and I will venture to say that the South American markets will henceforth be mostly supplied from this country, and as long as the South African War will last, more or less coal can and will be shipped to European countries.

Seven years ago I ventured the prediction to some of the coal men of Wales, that inside of ten years this country would produce more coal than Great Britain. They of course smiled and their looks intimated that they believed that to be another "Yankee Yarn," but that prediction came true in a much shorter time, because our tonnage last year (1899) was greater than that of Great Britain, and the greatest ever before produced by any country in the world.

I will now make another prediction, that in five years from now the production of coal in this country will be 25% greater

than that of Great Britain, and that the production of coal will be much greater than that of Great Britain 25 years from now, indeed to a much greater extent than what Great Britain produced more than this country 25 years ago, consequently it will become the greatest manufacturing country ever known to the world, and will continue to be so for many future generations.

Electrically Driven Bending Rolls.

The rolls are solid wrought-iron forgings arranged in pyramid form, and have a capacity for bending plates up to 12 in. in width and $\frac{1}{2}$ of an inch thick.

The lower rolls are geared together while the upper or bending roll is revolved by the friction of the plate in passing through. It is adjustable by power to suit the thickness of the plate and the radius to which it is to be bent. It has a hinged bearing at one end which may be turned down out of the way, while the other end has a long shank extending to a third support which retains the roll in position for the removal of rings or flues. This will be found a great advantage in boiler and other shops where plates are to be bent to a complete circle.

Midway between the housings supporting rollers are placed to give additional stiffness to the lower rolls. For very long machines additional sets of rollers are added.

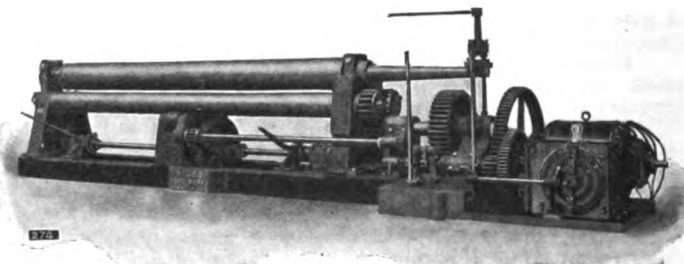
The machine is firmly tied together by a heavy cast-iron soleplate. It is very strongly geared and all parts are made stiff and substantial.

Suitable levers and clutches are conveniently placed for the quick and easy control of all the operations.

The machine is driven by an 18 H. P. reversible, constant-speed Bullock motor. For controlling the motor, an automatic rheostat is used to prevent the operator from throwing on the full current too quickly and burning out the motor.

The field consists of a circular yoke of special steel. While particular attention has been given to a reduction in weight, it has not been at the sacrifice of efficiency.

The pole pieces, built up from soft sheet steel of the highest magnetic quality, are securely bolted to the yoke. The shape of



the punchings are such as to produce a saturated pole face, and this feature, coupled with carefully proportioned windings, is largely responsible for the sparkless operation of the motor, and is a feature greatly appreciated by engineers.

The field coils are machine wound and carefully insulated. The shunt and series coils of compound-wound machines are separately wound. The coils are slipped over the pole before it is bolted to the yoke, and, should it be necessary, are readily removed.

The armature core is built up from thin, carefully annealed sheet steel, possessing a high magnetic permeability. These disks are again annealed and then japanned. They are mounted upon the shaft and held firmly together by malleable iron end plates.

The windings, which are let into slots provided in the periphery of the armature core, are made of either copper bars or wire as best suits the requirements. The coils are machine formed, and after being formed are thoroughly insulated with mica and other high-grade insulations. They are then baked in steam-heated forms while under pressure, which removes all moisture and produces a perfect and very compact coil. The result is a coil that is less liable to be injured than when produced by the ordinary method and one which requires no further insulation when placed in position on the core. The coils of armatures are held in position by wedges of hard, thoroughly dried wood, driven into notches provided near the top of the slots.

The commutators are built from drop-forged bars of pure lake copper with selected mica insulation. They possess great durability and have an exceptionally even wearing surface for the brushes.

The brush holder is simple and highly efficient, giving absolutely no trouble. It is of the reaction type; no adjustment of the brushes is necessary, and when they are once set the motor will operate in either direction without sparking and under all variations of load.

Anthracite Statistics of Pennsylvania for 1900.

We are able to print these advance statistics for the anthracite coal region of Pennsylvania through the courtesy of the Hon. James E. Roderick, Chief of the Bureau of Mines, Harrisburg, Pa., to whom we are indebted for the figures given in the following tables.

In considering these statistics, it must be borne in mind that the year 1900 cannot be considered a representative year as regards coal mining conditions in the anthracite field. During the great strike which lasted from September 15 to October 29, about 6 weeks, mining operations were practically at a standstill throughout the region, excepting in isolated cases, the only district in which mining was carried on to any extent being the Panther Creek district. Hence, the statistics for the year cannot be used as a basis for any general conclusions, excepting in the case of a few items which were not affected by the general idleness during so large a part of the working year.

Had the same rate of production prevailed over the entire year as did prevail during the time when the mines were working, the product of the year would have been a record breaker, but as the production prior to and immediately succeeding the strike was abnormal, we are not warranted in assuming that the production for the year if the mines had worked full time, would have been proportionate to the output during the time that they actually worked. From the number of men employed and from the known conditions throughout the region, it is safe to say that the production under normal conditions throughout the year would have been about the same as during the preceding year.

The figures for an average number of days worked during the year are probably those which are most misleading. This is shown by the fact that normally a difference of only nine working days less in 1900 than in 1899 would not mean a decrease in production of nearly 3,000,000 tons. Owing to the disturbed conditions during the strike and immediately preceding and succeeding it, it is impossible to obtain accurate data for this item. During such troubled times, collieries were frequently reported as working and, while this may have been theoretically true, practically they were at a standstill. The average number of working days is therefore probably too large.

In speaking of the anthracite mines, it is generally assumed that one anthracite mine is like any other and the great differences existing in the mining conditions between the different sections of the anthracite field are not usually appreciated. Thus, the conditions in the thin flat seams of the Upper Lackawanna Field are essentially different from those in the thick and steeply dipping seams of the Schuylkill and Mahanoy regions. No one item probably shows this better than the amount of powder used in the several inspection districts, or rather the amount of coal won per keg of powder used, $2\frac{1}{2}$ times as much coal being obtained per keg of powder in the Eighth Inspection District as was obtained in the First Inspection District. The following table for the years 1899 and 1900 shows this variation:

Inspection District.	1899.	1900.
1	32	31.2
2	38	31.3
3	32	34.4
4	40	40.6
5	57	59.4
6	48	49.6
7	34	48.
8	68	70.4
Average	39.4	49.4

Another table compiled from the statistics for 1900 shows that while the number of mules in use has remained practically the same during the past four years there has been a decided increase in the number of steam, electric, and compressed air locomotives, indicating both the superiority of motor haulage over animal haulage and also the increasing distance to which the coal must be hauled.

TABLE SHOWING THE VARIATION IN THE NUMBER OF MULES AND DIFFERENT FORMS OF MOTOR HAULAGE AT THE ANTHRACITE MINES OF PENNSYLVANIA FROM 1897 TO 1900.

	Mules.	Steam Locos.	Electric Locos.	Compressed Air Locos.	Electric Dynamos.	Air Compressors.
1897	15,877	*	*	*	*	*
1898	15,907	*	11	7	30	*
1899	15,690	352	29	24	45	116
1900	15,708	365	38	30	60	139

* No report.

Total Number Tons of Coal Mined, Shipped, etc., Number of Days Worked, Number of Employees, Number of Persons Killed and Injured, Number Kegs of Powder and Pounds of Dynamite Used, Also Number of Horses and Mules, Locomotives, Boilers, Engines, Pumps, Dynamos, and Air Compressors, in the Anthracite Districts of Pennsylvania, for the Year Ending December 31, 1900.

Districts.	Shipments of Coal in Tons by Rail or Otherwise.	Number of Tons Used for Steam and Heat at Collieries.	Number of Tons Sold to Local Trade, and Used by Employees.	Total Production of Coal in Tons.	Average Number of Days Worked.	Number of Persons Employed.	Number of Fatal Accidents.	Number of Non-Fatal Accidents.	Number Kegs of Powder Used.	Number Pounds of Dynamite Used.
First	5,841,044.00	440,014.00	87,870.00	6,368,948.16	161.5	17,285	40	118	204,359	142,735
Second	5,870,752.00	353,408.00	204,952.00	6,429,112.00	160	16,789	55	152	205,490	104,219
Third	5,658,947.12	511,220.03	126,763.09	6,296,931.08	154	18,600	59	139	183,122	278,769
Fourth	7,561,774.10	780,975.00	242,991.15	8,585,741.05	161.96	28,067	71	244	211,405	443,093
Fifth	5,843,291.19	712,921.11	114,570.10	6,170,784.00	195	15,111	40	76	103,943	980,811
Sixth	6,053,635.14	870,188.05	96,747.08	7,020,571.05	173	20,278	65	130	141,682	499,060
Seventh	5,204,543.05	689,904.19	116,243.02	6,070,701.06	169	20,655	49	91	126,465	503,065
Eighth	3,677,569.00	522,301.00	74,638.00	4,274,528.00	195	12,041	32	107	60,714	502,899
Total for 1900	45,271,608.00	4,880,932.18	1,064,776.20	51,217,318.00	171	143,826	411	1,057	1,237,180	3,454,641
Total for 1899	47,960,901.00	4,971,910.00	1,111,413.00	54,034,224.00	180	140,583	461	1,030	1,372,691	3,649,417

Districts.	Number of Horses and Mules in Use.	Locomotives.			Number of Boilers.				Number of Steam Engines of All Classes.	Total Horsepower.	Number of Pumps Delivering Water to Surface.	Capacity in Gallons Per Minute.	Quantity in Gallons Delivered to Surface per Minute.	Number of Electric Dynamos.	Number Air Compressors.
		Steam.	Air.	Electric.	Cylindrical.	Horse-power.	Tubular.	Horse-power.	Total Horse-power.						
First	1,858	40	11	11	368	9,183	144	15,845	25,388	494	30,076	82	61,416	41,714	15
Second	1,981	24	8	9	371	11,031	107	15,585	26,171	415	27,123	86	48,384	27,334	3
Third	2,148	40	3	4	342	9,784	202	29,836	39,620	562	50,132	146	90,750	50,180	11
Fourth	2,736	43	7	7	827	31,150	236	33,898	63,838	734	88,888	97	75,929	38,747	7
Fifth	1,642	106	9	.....	678	20,845	285	31,306	62,150	533	34,649	174	153,082	85,931	13
Sixth	2,009	42	6	.....	550	19,079	231	37,965	57,074	515	34,570	140	94,870	59,847	2
Seventh	2,029	40	1	6	892	13,883	260	34,425	49,308	345	32,788	125	64,208	35,870	5
Eighth	1,805	30	.....	1	306	8,490	228	28,424	35,909	288	23,980	67	57,386	26,778	9
Total for 1900	15,708	365	30	38	3,834	123,445	1,743	226,814	349,458	3,826	322,246	917	646,025	366,401	60
Total for 1899	15,690	352	24	29	4,235	139,774	2,108	210,223	350,007	3,764	288,100	979	631,630	349,530	45

LITCHFIELD HOISTING ENGINES

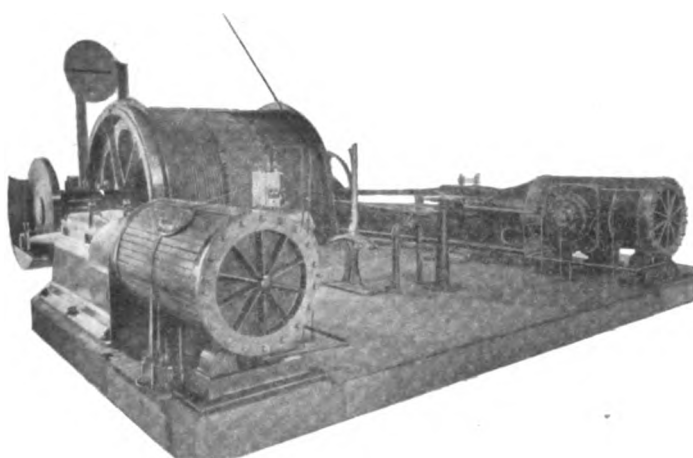
At Divernon Mine, Forming Part of Madison Coal Co.'s New and Complete Outfit.

In connection with the enormous increase in the development of bituminous coal properties during the last two years, and the sharp competition which has arisen, the successful and economical hoisting of coal has become one of the most important factors.

The accompanying illustration shows a pair of 24 in. $\times$ 36 in. engines built by the Litchfield Foundry & Machine Co., at Litchfield, Ill., for the Madison Coal Co.'s mine at Divernon, Ill. This mine is located on the Illinois Central Railroad, 15 miles south of Springfield. The shaft was sunk and equipped under the personal supervision of Mr. A. J. Morsehead, general manager of the Madison Coal Co., and is one of the best and most completely equipped mines in the State.

The buildings are all of brick, the main building containing a modern, up-to-date machine shop fitted with two engine lathes, pipe-cutting and threading machine, plane and radial drill. This machine shop is operated by a 12-horsepower electric motor. In the same building are located the hoisting engines, electric power and lighting plant, and the boiler room, in which are installed four boilers, each 72 in. $\times$ 22 ft., with twenty-six 6-inch tubes, and there is room for two more of the same size when required.

The coal is of the geological seam No. 6, is 8½ ft. thick, and lies 375 ft. below the surface. The hoisting and air shafts are of the same size, 17 ft. 2 in. $\times$ 8 ft. 7 in. inside the curbing. The ventilating fan is 22 ft. in diameter, and is driven by a 16 in. $\times$ 20 in. horizontal engine. Halbert's patent self-dumping cages are used,



the coal passing over all iron screens, 47 ft. $\times$ 7 ft., the shaking engine for this screen being 16 in. $\times$ 20 in., and also furnishing power for conveyer and surface-car haulage.

The steel shaft tower is set on concrete foundations about 3 feet outside of the curbing, so that the curbing of the shaft is entirely independent of the tower. There are three railroad tracks running side by side for the loading of cars, each track being 2,400 feet in length, with the tower set in the middle of them, so that the tracks will hold as many loaded as there are empty cars. The bottom curbing of the shafts is separated by iron columns, and the bottom has a 1% grade, coal being caged on one side so that cars gravitate to the cage, pushing off the empties, which run from the cage by gravity. The mine will be fitted up with electric locomotives for hauling the cars, and it is expected that small storage motors will take up the coal at the face workings. The pit cars are 5 ft. $\times$ 7 ft. inside and easily hold 3½ tons. Track is 42 in. gauge, and in all main haulageways the rails are 35 lb. per yard. Slate and other stuff between cap rock and coal is removed. The mine is worked by electric undercutting machines which derive their power from two 100-K. W. dynamos, which also furnish current for electric pumps, machine shop, etc. It will thus be seen that an immense output may be brought to the bottom of the shaft, and a description of the hoisting engines may be of interest.

They are of the well-known "Litchfield" type, first-motion engines. The diameter of cylinders is 24 in., stroke 36 in. They are provided with link reversing motion and D slide valves, fitted with the Litchfield patent balance attachment, the principle being to introduce a steam pressure tending to pull the valve off the seat, the magnitude of this pressure being slightly less than that which holds the valve on the seat. This "holding back" pressure is transmitted to the valve itself by means of hardened

steel rollers and brackets bolted to back of valve. This roller bearing is so arranged, and the steam pressure is so proportioned, that the engine may be reversed as easily under full steam as when shut off. The links and hangers are of cast steel, skeleton pattern, locomotive style, with hardened steel blocks, and are counterbalanced by levers with adjustable weights, making them work easily and smoothly. The pins in link motion are steel. The guides and crossheads are of extra heavy pattern, style known as locomotive four-bar guides, the lower guides being cast solid with engine beds. The connecting rods are of the best hammered iron, turned and polished, fitted with straps and brasses, the straps secured to rods by two taper bolts in each end, brasses made in halves of the best quality of metal and adjustable for wear by a taper key. The cranks are of disk pattern counterbalanced to overcome weight of connecting rods. The main bearings are of the style known as four-part box, fitted with quarter boxes adjustable for wear, with wedges running full length of bearings. No setscrews are used. The drum is 8 feet diameter and 8 feet long, built of dry oak staves on four massive cast spiders, which are all made in halves, and furnished with positive motion indicator driven from engine shaft. Two powerful wood lined band brakes are furnished, one being at each end of drum. The housings are cast solid with the outer drum spiders and then accurately turned in boring mill, thus insuring their being truly round and concentric with engine shaft. Brake lever, throttle wheel, and reverse lever are conveniently placed so they can be handled by the engineer either separately or simultaneously as required. A quick operating relief valve in connection with the throttle gives the engineer perfect control over the engine in landing cages and in lowering heavy loads. The cylinders are lagged with wood to prevent loss from radiation, and are furnished with automatic cylinder cocks.

The engines are of the standard pattern as made by this company in sizes from 16 in. $\times$ 30 in. to any desired size, two pairs with 30 in. $\times$ 42 in. cylinders having recently been built for the Mexican Coal & Coke Co., for their slope mines in Old Mexico. They are built with a large range of equipment, including straight face and conical drums, keyed to the shaft or provided with brass bushings and friction clutches for slope or tail-rope haulage. Of the latter class, the pair of 24 in. $\times$ 48 in. engines now in use at Ansted, W. Va., at the mines of the Gauley Mountain Coal Co., afford a good example. In the past two years this company has made over fifty pair of these first-motion engines, which are now in use in various parts of the country, including Washington, Montana, California, Indian Territory, Pennsylvania, West Virginia, Illinois, Missouri, Indiana, Canada, and Mexico.

TRADE NOTICES.

Hooven, Owens & Rentschler Co., of Hamilton, Ohio, manufacturers of the Hamilton Corliss engine, have installed another Cross oil filter, made by the Burt Mfg. Co., of Akron, Ohio.

The Bethlehem Steel Co. has moved its Chicago offices to larger quarters in rooms Nos. 1520 and 1521 Marquette Building, where it will continue to be represented by E. Nelson, sales agent.

The Cling-Surface Mfg. Co. will have a very complete working exhibit in the Machinery Building of the Pan-American Exposition where they will show belts running with and without Cling-Surface and demonstrate the advantages derived from its use.

The Ashton Valve Co. has recently appointed Mr. Frank J. Corbett, as assistant manager of its New York office, 121 Liberty St., where he will more especially introduce the lines of Ashton pop safety valves and steam gauges among the architects and stationary engineers of Greater New York.

The F. M. Sibley Lumber Co., of Detroit, Mich., in a postscript to a recent letter to B. F. Sturtevant Co., Boston, says "the Sturtevant exhaust head we bought of you last winter, is perfection itself. We are very much pleased with same. It keeps our mill roof as dry as if there were no exhaust at all."

The Central Electric Co., 264-270 Fifth Avenue, Chicago, has issued a circular giving later prices than those quoted in the latest catalogue of the company. This circular should be in the hands of all purchasers of electrical goods, and will be furnished upon application to the above address.

The Risdon Iron & Locomotive Works, of San Francisco, recently closed what is probably the largest contract for gold dredging machinery ever let, amounting to some \$200,000. The same company has contracted for the supply of four of their 5-foot dredges of their latest design for the Oroville district. This makes six standard dredges now building at these works.

The R. D. Nuttall Co., of Pittsburg, Pa., has appointed Mr. H. M. Lofton, 238 Equitable Building, Atlanta, Ga., as their southern representative. Mr. Lofton is not only a well-known street-railway man, but is also widely known in other mechanical lines through former prominent positions that he has held.

The Pittsburg Seamless Bottle Co. have awarded contracts to Wm. B. Scaife & Sons, of that city, to design, manufacture, and erect the buildings for their new glass factory at Everson, Pa. Among the larger structures are the main factory building, mixing rooms, lehr building, boiler and engine houses. Steel frame construction is to be used throughout.

Hooker Steam Pump Co. has moved its shops into new works of increased size and capacity at the corner of Channing and Franklin Avenues, St. Louis, Mo. By means of improved and special machinery and with newly equipped shops this company is now in shape to build steam pumps of all kinds and will shortly undertake the manufacture of air compressors as well.

Messrs. Hyde Brothers & Co., 902 and 903 Lewis Building, Pittsburg, Pa., have recently closed their fourth contract with the American Rolling Mill Co., of Chicago, Ill., for 500 H. P. of their boilers to go in the new plant at Muskegon, Mich., a fourth contract with the Ohio Falls Iron Co., of New Albany, Ind., for 500 H. P. of their boilers, and a third contract with the American-McKenna Process Co. for 1,200 H. P. of their boilers to be used at the new plant in New Jersey.

Messrs. Jas. McCrea & Co., have moved to 67 West Washington St., Chicago, where they have two floors and a store, giving them outside of their office about 5,000 square feet for manufacturing space. They will take up the manufacture of a line of steam specialties which indicates the increasing success of this company. Messrs. McCrea & Co. report that they have thus far in the current year each month doubled the business of the corresponding period of last year.

An order was placed with the Edward P. Allis Co., of Milwaukee, through their Spokane office, by the Mountain Copper Co., Ltd., of Keswick, Cal., for machinery for a copper converting plant, consisting of three stands of converters, blowing engine, electric crane, and all the necessary appurtenances belonging to a converting plant. It is expected that the plant will be in operation in about six months. The total shipping weight of the machinery sold is approximately 500,000 pounds.

The Atlas Pipe Wrench Co. has received a letter from Mr. Cooley at Albuquerque, New Mexico, foreman of the water service of the Atchison, Topeka & Santa Fe R. R. Co., after tests of the Atlas pipe wrench made at the request of Mr. Nevin of the same railroad at Los Angeles, Cal., from which the following is an extract: "I have used the wrenches on our work with better satisfaction than any wrench we have employed heretofore. They excel all pipe wrenches in all the important points of a perfect tool for handling pipe."

The Manufacturers' Association, of Kansas City, Mo., has established a catalogue library, and requests all manufacturers and mercantile establishments to forward their catalogues, receipt of which will be duly acknowledged. Catalogues will be filed and indexed by the card-index system both as to firm name and subject matter of the catalogue. The Association will maintain standing advertisements in all of the local papers announcing that the catalogue library is at the service of any one, and that inquiries by mail, which can be answered by reference to the catalogue library, will be promptly and freely replied to.

The Carroll-Porter Co., whose works at Pittsburg, Pa., were destroyed by fire late in the summer of 1900, have located at Wellsville, Ohio, where they have secured six acres of land, convenient for shipping both by river and rail. Their new buildings are nearly completed, and they will have more than double their former capacity at Pittsburg. They make riveted pipe for water, gas, etc., and from six inches diameter up to six feet, or more. When in their new plant they will make their own rivets, and machinery, and do all their own repair work. They will maintain offices in Pittsburg, as at present.

The Williams Patent Crusher & Pulverizer Co., of St. Louis, Mo., has opened a branch office in charge of Mr. M. J. Williams, in the Temple Court Building, 225 Dearborn St., Chicago, Ill., where they will be pleased to meet any who contemplate the installing of grinding machinery of any kind, and other specialties. They are at present very busy, filling orders for Europe, and have recently booked orders for the U. S., for Durango, Col., Allegheny City, Pa., Abbots, Ark., San Francisco, Cal., Newport Tenn., Buena Vista, Va., Big Stone Gap, Va., Eckman, W. Va., and several others, and report a very bright outlook.

The Eastern Granite Roofing Co., formerly at Jersey City, N. J., removed May 1 to the Gerken Building, 90-92 West Broadway, New York. This progressive firm also celebrates with the month of May the opening of its new and extensive

works equipped throughout with the latest and most approved machinery, nearly all of which is of the firm's own invention. The Eastern Granite Roofing Co. now has the largest and most complete plant in the world for the production of stone-surfaced roofing and perfected granite roofing, the standard "Ready to Wear" roof covering of America will continue to hold its place in durability, sightliness, ease of application, and fireproofing qualities.

The Patent Office in Washington desires to receive from manufacturers and publishers such catalogues, circulars, price lists or other advertisements relating to the sciences and mechanical arts as are published by them for gratuitous distribution; notice is, however, given to such manufacturers or dealers who feel disposed to send their publications that not less than three copies should be forwarded in order that the subjects may be properly indexed, classified, and subclassified in the Scientific Library for convenient and ready reference. Manufacturers will find it advantageous to comply with this request, since catalogues and advertisements are frequently cited by examiners and held to be anticipations of claims made by supposed inventors.

The Denver Engineering Works Co., Denver, Colorado, has issued a bulletin, No. 1,004, describing the Improved Cammett concentrator. The pamphlet is completely illustrated by half-tone cuts showing the concentrator in its various parts, which gives one a clear idea of its construction. Also complete dimensioned drawings of both table and countershaft are given, together with general data, so that one designing a mill, and desiring to show a Cammett table in the plans, will find all the necessary information for so doing. The most noticeable improvements which have been made recently on the concentrator are the simple and efficient head motion, and the pulp distributing box. The bulletin includes working drawings of classifier, with the dimensions of various sizes conveniently tabulated. It also includes a classified list of the more important minerals, together with their specific gravities, which will be found a useful reference for men engaged in ore concentration. This bulletin will be forwarded on application to any one requesting it, and we recommend it to those who desire to be fully informed regarding the most advanced concentrating methods and appliances.

April 7, the John A. Roebling's Sons Co. took the first important step in the making and laying of the cables for the new East River bridge at New York. The contract was awarded to the company several months ago, and the preparation of plans and other preliminary work, as well as the main part of the contract, which is to follow, is under the supervision of Mr. Charles G. Roebling, the president of the company, who is assisted by Mr. William Hildenbrand. The first work done was the placing in position of the 24-inch diameter ropes which support the temporary foot bridge on which the workmen will stand during the main work of cable laying. Several methods of getting the first line across have been employed in the past, and kites, swimmers, and other agents have been tried, but the method employed on this occasion has, we believe, never been tried before, and is a distinct advance over all previous ones. The method adopted was to carry the drum containing the cable across the river on a float (one end having previously been secured) and pay out the cable, allowing it to rest on the river bed until at the proper time it could be raised from the water and to the desired height by means of a stationary engine and drum. The first cable was successfully raised on April 11, the time required being only seven minutes, navigation being, of course, suspended during that period.

The Gates Iron Works, Chicago, Ill., has recently sold a complete copper smelting and converting plant to the Granby Mining & Smelting Co., of Grand Forks, British Columbia, this being a second order from the same concern. This order completes one of the largest copper smelting and refining plants built in the United States or Canada. The success obtained by the Granby Mining & Smelting Co. with its initial plant has been unequalled. The plant consisted of two rectangular water-jacketed furnaces, 44' x 160', with all the necessary appurtenances incident to a modern copper smelting plant. The plant was installed at Grand Forks, B. C., to handle the low-grade copper ores in the Boundary District, and was designed to handle 500 tons per day. Under the direction of the superintendent, Mr. A. B. W. Hodges, the plant has averaged 600 tons per day, and has reached as high as 763 tons. The Granby Co. has, within the last month, completed smelting its first 100,000 tons, and has reached a low cost of mining and smelting that has made a new record. To complete this plant, the Granby people have just placed their second order with Gates Iron Works, consisting in part, of two more water-jacketed furnaces, 44' x 160'; a complete ore-crushing and sampling works, with No. 5 Style "D" crusher, one 9' x 15' Blake crusher, one "F" Gates crusher, one sample grinder, three sets of rolls, elevators, etc.; a complete silica crushing mill, including a Dodge crusher, dry pans, rolls, elevators, etc., and

the following converting machinery: one tilting reverberatory furnace complete, one converter stand complete, cars, a complete hydraulic system, blowing engine, one 10-ton electric crane, one 40-ton electric crane, with everything complete to make a perfect plant. The Granby smelting and refining plant will be a model in every respect. The company has unlimited resources of ore, and are working over two miles of development; the production of over 1,200 tons of ore per day is well within the possibilities of the mine. The magnificent water-power and the unequalled location further insure the permanent prosperity of this great enterprise, which ranks today as the foremost mining proposition in British Columbia. The water-power which cost \$100,000, not only furnishes the power for the smelting and converting plant, but the company also furnishes the electric power for the city of Grand Forks. It is undoubtedly one of the most interesting mining enterprises in the country.

The Bullock Electric Mfg. Co., of Cincinnati, and the Wagner Electric Mfg. Co., of St. Louis, have effected a combination of their selling organizations. By thus combining forces in the field, they are mutually benefited, inasmuch as the products of the two companies are totally different, and where the product of one is used, the other is likely to be necessary. The product of the Bullock Co. consists of a complete line of direct- and alternating-current machines, from a $\frac{1}{2}$ -horsepower motor to a 10,000-K. W. generator; controllers of various types and rotary transformers. The Bullock "Teaser" power system for driving large daily newspaper presses has become world famous and is today installed in the press rooms of the leading dailies in Europe and America. The product of the Wagner Electric Mfg. Co. covers a full line of static transformers of all types and of the largest sizes; ammeters, voltmeters, indicating wattmeters, switches, switchboards for all purposes, and single-phase self-starting alternating-current motors. The entire absence of complicated starting mechanism especially adapts the Wagner single-phase motor to pumping plants and machinery of like character. Thus it will be seen that the two lines are admirably adapted to be sold by one organization, which will be under the management of Mr. E. H. Abadie, formerly sales manager of the Wagner Co.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

- B. F. STURTEVANT CO., Boston Mass. Disk and Propeller Fans. 16 pages.
- A. WYCKOFF & SON CO., Elmira, N. Y. "Mine and Acid Proof Pipes."
- THE PHILIP CAREY MFG. CO., Lockland, O. Carey's Special Air Chamber Covering.
- HOOPER PNEUMATIC MILLING CO., 515 West 30th St., New York. "Steam Dryer." 4 pages.
- JENKINS BROS., 71 John St., New York. The Jenkins Bros.' Valves and Disks. 74 pages.
- JEANESVILLE IRON WORKS CO., Jeanesville, Luzerne County, Pa. Advance Sheet No. 9. 4 pages.
- HERZLER & HENNINGER MACHINE WORKS, Belleville, Ill. "Coal Mining Machinery." 12 pages.
- BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record of Recent Construction. 32 pages.
- SPRAGUE ELECTRIC CO., 527 West 34th St., New York. Lundell Fan Motors. 28 pages.
- HYATT ROLLER BEARING CO., Harrison, N. J. "Power Transmission Machinery." 96 pages.
- THE DENVER ENGINEERING WORKS CO., Denver, Colo. Improved Cammett Concentrator. 20 pages.
- L. SCHUTTE & CO., 12th and Thompson Sts., Philadelphia Pa. "Universal Condenser." 24 pages.
- THE BABCOCK & WILCOX CO., 29 Cortlandt St., New York. Steam from Green Bagasse. 16 pages.
- DAVIS CALYX DRILL CO., 128 Broadway, New York. "Core Drilling Without Diamonds." 48 pages.
- ROSSITER, MACGOVERN & CO., 141 Broadway, New York. Electrical and Steam Machinery. 40 pages.
- THE COIL CLUTCH MFG. CO., 45 Broadway, New York. "Lindsay's Patent Coil Friction Clutches." 4 pages.
- CHICAGO HOUSE WRECKING CO., West 35 and Iron Sts., Chicago, Ill. The Monthly Bulletin, March, 1901. 28 pages.
- THE JOHN F. BYERS MACHINE CO., Ravenna, O. Catalogue "F." Geared Locomotives, etc., Contractors and Builders' Supplies. Illustrated. 82 pages.
- THE J. H. MONTGOMERY MACHINERY CO., 1220 Curtis St., Denver, Colo. 170 pages. Pocket Catalogue of Common Sense Mining Machinery. Short Rules and Useful Information.
- GENERAL ELECTRIC CO., Schenectady, N. Y. General Electric Fan Motors, 52 pages. Parts of Brush Arc Lamps, 41 pages.

Interchangeable Arc Lamps, 50 pages. Repair Parts of GE-800 Railway Motor, 25 pages. Parts of Carbon Feed Enclosed Arc Lamps, Form 5 for Direct Current Multiple Circuits, 15 pages. Parts of Carbon Feed Multiple Enclosed Arc Lamps Form 1 for 220 Volt Direct Current Circuits, 14 pages. Bulletin No. 4229, 8 pages. Bulletin No. 4242, 8 pages. Bulletin, No. 4243, 8 pages, Bulletin No. 4245, 4 pages. Bulletin No. 4244, 4 pages. Protective Device for Transformers, 1 sheet.

Test of 5 Ft. × 16 Ft. Capell Ventilating Fan,

At Mill Creek, Pa., Sept. 2, 1900, by the Cambria Steel Co.

SUMMARY OF RESULTS.

No. of Test.	Time of Test.	Revolutions per Minute.	M. E. P. Lb. Per Sq. In.	Indicated H. P. in Engine.	Water Gauge.	Initial Steam Pressure.	Total Volume of Air.	H. P. on Air.	Useful Effect.
1	1.30 P. M.	222	59.70	873.4	7.875	95.5	254,701	816.1	84%
2	1.35 P. M.	219	58.85	863.1	8.187	96.0	257,491	832.2	91%
3	1.40 P. M.	220	59.30	867.8	8.062	98.0	223,184	288.5	75%
4	2.15 P. M.	187	48.85	256.9	6.062	83.0	227,180	217.0	84%
5	2.30 P. M.	190			6.125		198,302	191.4	
6	2.35 P. M.	189	42.35	225.7	6.187	72.0	216,021	210.6	87%
7	2.55 P. M.	184			5.687		208,104	190.6	
8	3.00 P. M.	187	41.95	221.1	6.250	76.0	197,925	194.9	88%
9	3.20 P. M.	178					166,634		
10	3.40 P. M.	175	86.55	180.1	5.125	90.5	163,142	185.7	75%
11	3.45 P. M.	162	30.65	139.9	4.375	85.5	145,899	100.6	71%
12	3.50 P. M.	161	39.35	139.2	4.500	86.8	153,816	109.1	78%
13	3.55 P. M.	153	28.75	123.9	4.000	84.0	153,062	96.1	77%
14	4.00 P. M.	145	25.35	103.6	3.625	80.0	146,276	83.6	80%

NOTE.—The engine, driving fan tested as above, is 20 in. × 18 in.

Salmon Car Wheel and Pedestal.

The illustration given on advertising page 78 of this issue of MINES AND MINERALS shows a mine car wheel, made by the Salmon Iron Co., of Freeland, Pa., which is said to have many points of superiority. Any style and size, and either chilled or not chilled can be made.

The special feature of this wheel is its oil-retaining device, briefly described as follows: On the outer end of the hub, covering the end of the axle and lynch pin which it keeps in place, is an oil-tight cap; on the inner end is a brass shield which is fitted in a slot, cut in the hub for that purpose. Said shield is bored to a snug fit for the collar, which is turned up as smooth as the journal of the axle. With the wheel thus equipped, no oil can possibly escape, but is retained in the hub until absolutely worn out.

The shield is practically indestructible, for the reason that the wheel may vibrate in any direction without producing friction or pressure upon the shield greater than its own weight which is about a pound.

The device that keeps the oil in, also keeps sulphur water, dirt, and other grit out, hence, friction is reduced to the minimum.

Being purely a metal device, there is no felt, waste, or other packing liable soon to be worn out, leaving openings for the escape of oil.

It will be noticed by the cut that a full bearing is secured, there being no cavities in the hub of the wheel.

A car having loose outside wheels has been in use at the Audenried Colliery of the Lehigh and Wilkes-Barre Coal Co., two years and four months, running an average distance of twenty miles per day, and yet does not show the $\frac{1}{16}$ part of an inch wear.

The Salmon Iron Co. is prepared to apply the principle of this patent to wheels, pedestals, or shafting of any kind, and will guarantee perfect satisfaction in every particular.

Fifty Dollars for a Photograph.

In his advertisement on page 45 of this issue, Mr. H. D. Crippen, manufacturer of the Jackson hand-power rock drill, 52 Broadway, New York, offers a prize of \$50 for the best photograph of a Jackson hand-power rock drill at work. In regard to this offer he says: "I am desirous of obtaining a collection of photographs showing the Jackson drill in operation in various mining properties. These photographs I intend to use for illustrating in my next catalogue and in a general advertising way. The merit of the photograph will be judged by its clearness and the advantage to which it shows off the Jackson drill, from a practical standpoint. The drill must be shown in apparent operation, the operator or operators being in a working position. Photograph may be taken of the drill in either shaft, tunnel, or stope. The contest is not limited to owner of drill, but complete data as to name and location of mine and its owner must accompany each photograph. Award will be made on June 1, 1901."

SLIME TREATMENT

In the Galena-Joplin Lead and Zinc District—Sludge Mills and the Methods Employed in Them.

Written for MINES AND MINERALS, by Prof. W. R. Crane.

Although the mining of lead and zinc ores in this district dates from the early seventies, yet not until within the last few years has any attempt been made to extract the ores from the slimes on a commercial scale. Along some lines the treatment of slimes has been more extensive in Joplin than in the Galena portion of the district, yet there is little advantage to be claimed between the two.

The apparatus used consists of classifiers, power and hand buddles, occasionally a round table, and Wilfley tables.

In the Joplin portion of the district classifiers are used quite extensively, while in the Galena portion, they are rarely employed.

The place occupied and the importance attached to the treatment of slime is shown in the following outline of the method of milling commonly employed in the district.

	From Mine	to
	Grizzlies	to
	Boulders	to 1
	Fine	to 2
1.	Sledge	to 2
2.	Crusher	to 3
3.	1st Set Rolls	to 4
4.	1st Elevator	to 5
5.	Revolving Screen	to
	Sized and Under	to 6
	Over-Sized	to 7
6.	Rougher-Jig	to 8
7.	2d Set Rolls	to 4 to 5
8.	Heads	to 9
	Middlings	to 10
	Tails	to Waste-pile.
9.	2d Elevator	to 11
11.	Cleaner Jig	to
10.	3d Elevator	to 12
12.	3d Set Rolls	to 4
	Heads (Finished Product)	
	Middlings	to 13
	Tails	to Waste-pile.
13.	4th Elevator	to 14
14.	Sand Jig	to
	Heads (Finished Product)	
	Middlings	to 15
	Tails	to Waste-pile.
15.	Slime Treatment.	

When classifiers are employed, they are usually attached to the rear end of the cleaner jig and are also arranged to receive the

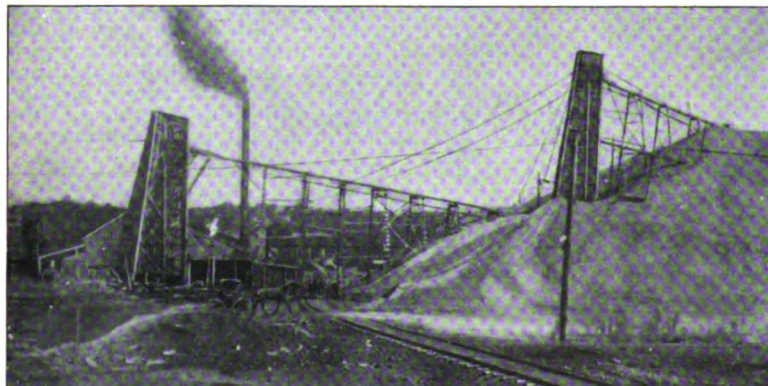


FIG. 1. MILL FOR SLIME TREATMENT.

drain from the hutch-work of the jigs. The slime thus obtained can be retreated, when no other form of slime treating apparatus is accessible, by the cleaner or sand jigs, with a special filter bed.

So far, the mine operators have been content to go no further than jigging, in the process of concentration, with the exception in some cases of the use of classifiers and by paying little or no attention to the slimes allow them to mix with worthless sand, thus rendering them unprofitable to work. When the slimes are not ruined by being surcharged with waste product, they are

eagerly sought for by the operators of the so-called sludge mills. The sludge mills are mills intended for slime treatment, solely. There are two classes of these mills, first, those in which rolls, jigs, and buddles are the forms of apparatus employed; and second, those containing rolls and Wilfley tables.

The sources of the material operated on are the slimes and tailings from the large concentrating mills. From a large number of analyses of the tailings throughout the district, it was found that the per cent. of blende remaining ranged from 3. to 7

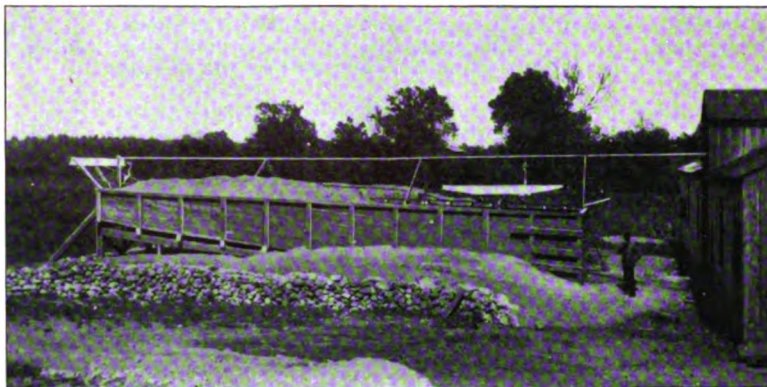


FIG. 2. AUTOMATIC FEEDING DEVICE FOR WILFLEY TABLE MILL.

per cent. It will therefore be seen that if such tailings were retreated, and a large part of the mineral saved, it would be, as has been shown, a paying proposition, especially as the tailings cost nothing except the expense of haulage, which is about 18 cents per ton. The slimes when valuable enough are occasionally sold at 50 cents per load, but more usually are given away as they encumber the ground.

The mills in which the concentration is done by means of rolls, jigs, and buddles, receive the slimes and tailings into an elevator by which they are raised and delivered into gravity spouts or launders, which conduct them to the revolving screens where they are sized. The sized product going to the cleaner jig, while the over-sized material is conducted to the first set of rolls, passing which it is elevated and fed to the cleaner jig. The heads from the cleaner jig go directly to the sand jig; the middlings are conducted to the second set of rolls. The material passing the second set of rolls, is returned to the cleaner jig. The tails from the cleaner jig are elevated and run off to the tailings pile.

The heads from the sand jig are usually clean enough to be sent to the smelter.

The middlings together with slimes collected at various points in the system already described, are elevated and carried by launders to the roughing buddle. The settlings of this buddle are divided into two parts, usually, which are shoveled out and treated in the cleaning buddles. When the mineral is rich, one rougher and two cleaners are employed; when poor, two roughers and one cleaner, are used.

The settlings from the cleaner, are divided into three heads: finished product, middlings, and tails. The middlings are retreated on the hand or square buddles. The tails are thrown away.

When the material treated is rich, the upper ten to twelve inches of the rougher settlings are clean enough to be sent to the ore bin; when poor, they will have to be retreated as outlined above.

Usually, the last foot of the settlings of the rougher buddle is thrown away. The remaining portion, when rich, is divided into two parts, otherwise, only one.

The finished product from the sand jig is usually meal-size, while that from the buddles ranges from 60 to 150 mesh, and even smaller.

Fig. 1, shows the mill formerly owned by Emmons & Crowe. The scheme of treatment of slime, as outlined above, was that followed in this mill. The exceedingly large tailings pile, as seen at the right of the mill, required two tailings elevators to raise the wastes to a height sufficient to run them off. This mill treated practically nothing but tailings.

The second class of slime treating mills, as given above, are those in which the Wilfley table is the only form of concentrating apparatus.

These mills operate almost wholly on tailings hauled from the larger concentrating plants. The wagons are unloaded into the automatic feeding device, as shown in Fig. 2, by which the tailings are fed into an elevator, thus raised 10 to 12 feet and

delivered to a revolving screen, where they are sized. The over sized passing downward is fed to one or two sets of rolls, depending on the amount of over-sized material and also the rate of speed, thence to the elevator by which they were first raised, and so back to the first screen again. The sized portion passes directly to the table.

The tables are arranged, part to act as roughers, and part as cleaners, usually one cleaner to two roughers.

The heads from the roughers are conducted by launders to the heads elevator, which delivers them to a second revolving screen. The oversized, going to a third set of rolls, is reduced and returned to the heads elevator, and thus delivered to the revolving screen a second time. The sized product passes to the cleaner table, where the heads are saved as finished product and the tails run off to the waste pile.

The water for the tables and automatic feed is furnished by a centrifugal pump, which delivers to a large tank located in the loft of the mill, from which the supply pipes lead.

The tables are usually arranged in a row to facilitate the feed, also the handling of heads and concentrates.

In both these types of mills, the capacity is rather small, especially in the Wilfley table mill. This is probably due to lean tailing, which in turn is due to closer and therefore more careful work on the part of the mill owners and operators in general.

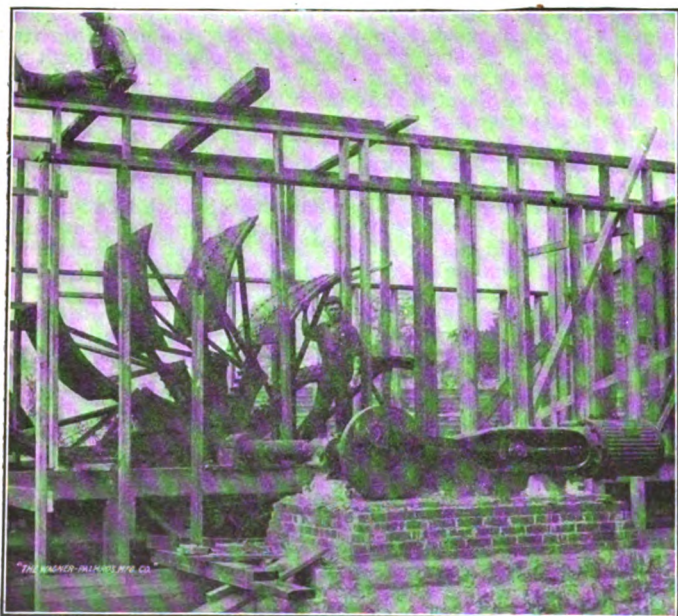
Undoubtedly a great saving could be made in the large mills by introducing some form of slime-treating apparatus, to treat the rich slimes from cleaner or sand jigs before they become mixed with waste material and thus rendered worthless.

It seems that a step in the right direction has been taken by the mill operators in the Joplin portion of the district where classifiers are employed to save the slimes resulting from the jiggling.

The round table has not proven satisfactory in the attempts made to use it here, due probably, to the lack of skilled operators. There is no reason why it could not be made a useful accessory to the regular concentrating apparatus already in use.

A New Mine Fan.

A mine fan which is of particular interest to our readers has recently been placed on the market by the Wagner-Palmros Mfg. Co. of Fairmont, W. Va. This fan was designed to conform to the



severe duties required in ventilating the large mines in the Fairmont district. As these conditions demanded a fan which should be capable of operating with the least possibility of accident it was necessary to construct one which would be of ample strength and of proper design to operate constantly. The fan has demonstrated itself to be capable of meeting these conditions in an entirely satisfactory manner.

The spider is made of one solid iron casting, having tangentially projecting arms, these arms being of such shape and size as to give maximum strength with minimum weight. The spider is mounted on a heavy cast-iron hub and held in place by large bolts passing through it and a flange on the hub. The hub

is shrunk and keyed on to the shaft, thus making it entirely secure and without possibility of working loose.

To each arm of the spider is bolted a channel which is shaped so that the blade when mounted will be of proper form to give maximum efficiency. Upon these channels is mounted a wooden blade, securely bolted in position by a double row of bolts; the blade is then braced to the opposite arm by means of heavy angles, one projecting from each corner of the blade. These angles are securely bolted and of such dimensions as to insure stability and strength. Along each row of bolts a plate liner is placed so that the bolt heads and nuts cannot work into the wood and become loose.

The illustration is that of a 15-foot fan, and shows the engine direct connected to the shaft.

Mineral Production of British Columbia.

Written for MINES AND MINERALS, by E. Jacobs.

From the returns of the mineral production of the Province of British Columbia for the year 1900, submitted to the local Legislature by the Provincial Minister of Mines on March 5, it is gathered that there was during the year an increase in the value of the output of the lode mines of the Province of \$3,310,428, and a decrease in that of placer gold of \$66,176, leaving a net increase in metallic minerals for the year of \$3,244,252. There was also an increase of \$1,013,238 in the value of coal and coke. No returns are yet available of the value of other non-metallic minerals, so these cannot now be taken into account. The foregoing figures, though, exhibit practically last year's increase, which was \$4,257,490, as shown in detail in the following table:

	1899.	1900.	Increase.	Decrease.
Placer gold	\$1,344,900	\$1,278,724		\$66,176
Lode gold	2,857,573	3,461,067	\$ 603,494	
Silver	1,663,708	2,295,099	631,391	
Copper	1,351,453	1,615,289	263,836	
Lead	878,870	2,690,577	1,811,707	
Coal and coke	4,053,651	5,066,889	1,013,238	
Total	\$12,150,155	\$16,407,645	\$4,323,666	

The total mineral production of the Province for all years up to and including the year 1900 is as under:

Gold, placer	\$62,584,443
Gold, lode	12,820,546
Silver	13,635,708
Lead	6,543,358
Copper	5,437,871
Coal and coke	49,426,700
Other minerals (approximate amount)	2,000,000
Total	\$152,448,626

The number of tons of metallic ore mined in the Province in 1899 was 287,343, and in 1900, 554,796, the increase for last year having been 267,453 tons. The respective increases, for 1900 over 1898 were: In quantity of metallic ore mined, 338,852 tons, and in value of metallic minerals, coal and coke, \$5,652,284, the latter being an increase of more than 50 per cent.

The figures for the whole of Canada for the year 1900 are not yet available but those for 1899, given in the following table, will serve to show the very important position the part of the Dominion lying west of the Rocky Mountains occupies in regard to Canada's total production in 1899 as compared with that situated east of the Rockies. It will be seen that the total value of metallic minerals, coal and coke produced in British Columbia and the Yukon was \$28,150,155 as against \$10,073,642 for the remainder of the Dominion.

	British Columbia.	Yukon District.	All Other Provinces.	Total for Dominion.
Gold	\$ 4,202,473	\$16,000,000	\$ 847,257	\$21,049,730
Silver	1,663,708		170,683	1,834,391
Copper	1,351,453		1,308,866	2,660,319
Lead	878,870		98,580	977,450
Iron			248,372	248,372
Nickel			2,067,840	2,067,840
Platinum			835	835
Coal	3,882,396		5,187,662	9,070,058
Coke	171,255		178,767	350,022
Total	\$12,150,155	\$16,000,000	\$10,073,642	\$38,223,797

As the output of coal in British Columbia is rapidly increasing and attention is now being directed to its iron deposits, it appears as though it will not be long before the mineral production of the province will be greater not only in the total, as at present, but as well in all the individual minerals (excepting nickel and platinum) than that of the remainder of the Dominion east of the Rocky Mountains.

OIL FIELDS OF CALIFORNIA.

A Description of Their Location, Formation, the Quality of the Product and Extent of Development.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

The existence of petroleum in California has been known for many years. The California Indians used it in the form of asphaltum for various purposes. In 1855 Andreas Pico distilled petroleum for the San Fernando mission. The crude oil was obtained from Pico Cañon in Los Angeles County. In 1856 a company worked at La Brea Ranch and tried to refine crude oil. In 1857, an attempt was made to produce illuminating oil from crude petroleum at Carpinteria in Santa Barbara County without success.

In 1865, Prof. B. Silliman reported on California petroleum and spoke favorably of obtaining petroleum remuneratively in the State and gave the results of his experiments in 'fractional distillation of California petroleum.'

Then followed a big oil excitement. Most of the companies were unsuccessful. The oil miners had not the drilling machinery of the present day, and they knew very little of the geology governing the occurrence of the oil deposit. The pioneer distillers thought by fractional distillation of California petroleum they would obtain similar products to those resulting from fractional distillation of the petroleum of the Eastern States, but they were disappointed.

The first successful refinery was at Newhall, Los Angeles County. At present there are refineries at Los Angeles, Chino, Ventura, Alameda, and Contra Costa counties. There has been steady increase in the amount of petroleum produced in California, and in the amount of territory developed.

California petroleum is found in formations ranging from the Lower Cretaceous to the Quaternary, principally in the Eocene and Neocene formations. A knowledge or study of the geology is very important in California, for wherever petroleum has been found in the State, geological disturbance has complicated the stratigraphical conditions. The rocks are curiously and wonderfully folded, the folds being generally very narrow; small folds constitute parts of larger folds. The small folds determine the course and width of "oil lines."

When the outcrop of the oil yielding stratum is found it constitutes a most important guide to the prospector. It shows the horizontal direction in which the oil sand extends and the angle at which it is inclined. From the latter factor the depth at which the oil sand can be struck by drilling at any distance from the outcrop can be calculated. Often the oil stratum does not outcrop at the surface. Its dip and strike must then be inferred from any rocks enclosing it exposed. Within a limited area the exposed strata show often a great diversity of dip, and the best guide as to the prevailing strike of the formation is the strike of the axis of the fold into which the strata have been thrown.

When the exposed rocks are situated near the axis of a fold, or when a fold of which they form a part is overturned, they are by no means an infallible guide as to the prevailing angle of dip. In locating an oil well the character of the fold affecting the rocks about to be prospected should be taken into account. Faults may determine the existence and course of "oil lines." The commonest faults are those caused by fractures extending along the strike of the formation which have allowed blocks of the earth's crust to slip past one another in the form of steps, in other words "step faults." In areas of great compression like the Coast Range instead of thrust faults the fault fracture is vertical, the force of gravity controlling the thrust.

A large part of California is an elongated oval basin known as the Sacramento and San Joaquin valleys, 400 miles long by 80 miles wide, bounded on the north by the Sierra Nevada Range, and on the south by the Coast Range.

Sedimentary rocks deposited by the sea on the northeast side of the basin at the foot of the Sierras are not much disturbed, and lie 400 to 500 feet above sea level, showing they were raised "en masse," whereas, on the southwest side of the basin and throughout the entire Coast Range, the unaltered marine rocks are greatly contorted, broken, and faulted, showing they were not only raised "en masse," but were uplifted and twisted by great movements after their deposition. These unaltered rocks cover an

area of 40,000 square miles, all containing bitumens in greater or less quantity.

The Coast Range consists of a series of more or less anticlinal parallel ridges, broken by transverse passes and separated by synclinal valleys. It extends along the entire coast length of California. The ridges frequently coalesce, and the cores of the main anticlines are granitic or metamorphic.

Nearly all of the marine sedimentary rocks have been denuded from the sides of the Sierra Nevada Mountains, exposing great masses of plutonic and metamorphic rocks. There is but little exposure of the granitic rocks on the Coast Range. These appear on the axes of the anticlines forming the summits of the mountain ridges. The upper more recent metamorphic rocks, serpentine and jasper, are but little eroded, and large areas and masses of unaltered marine rocks repose upon altered rocks on the sides and summits of these mountains. Anticlinal folds will run from a few miles to many and then die out or coalesce, these undulations forming a chain of domes.

Some of the oil sands which now lie 2,000 feet above the ocean level must have been at some time 10,000 feet below it. At some places the metamorphic rocks are at contact with the oil sands, while at other points only a few miles distant, these rocks are over 1,500 feet below the same oil sand. The metamorphic rocks were evidently formed from the unaltered rocks. As many as 10 beds of sandstone, with intervening shale can be seen on the eroded sides of some of the anticlinal ridges. They are irregular in thickness, from a few feet to 400 feet, and the intervening shales may be from a few feet to 500 feet in thickness.

In Santa Clara County, near Sargents, the sandstone beds are separated from each other by beds of shale. The sandstones dip south and rest unconformably upon shales, standing nearly vertical. The outcropping sandstones are sometimes bituminized, especially in the geologically lower beds.

Many sand beds overlying bituminized sand beds are calcified and contain fossils, whereas the bituminous sand rocks contain but few fossils of lime, they having been leached out of them by water prior to the entrance of the petroleum.



HILLS NORTH OF TREMBLOR VALLEY. A TYPICAL VIRGIN OIL FIELD.

The accompanying illustration shows a range of hills running east and west and lying north of the Tremblor Valley in the McKittrick oil district. A is the axis of the anticline. B B B B are the strata forming these hills, lying east of the anticlinal axis, and having a persistent dip toward the east. Considerations of the distance of these exposures and dip of strata would show a geological thickness of strata approaching 10,000 feet, and as no metamorphic rocks are uncovered near the axis of the anticline, the metamorphic rocks may lie at a great depth below the surface.

Asphaltum oil seepages and other indications of petroleum are scattered throughout these hills. The interspaces in a cubic foot of sand will hold one and one-half gallons of petroleum oil. A volume of sand equal in area to one acre and 100 feet thick will hold, in round numbers, 6,600,000 gallons of petroleum or 167,000 barrels. So a small area may produce a large amount of oil. The large area covered by the unaltered rocks and their great thickness, consisting of numerous alternating beds of sandstone and shale, make the possibilities of oil in California seem like a fairy tale.

A MINERS' ASSOCIATION.

A California Petroleum Miners' Association has been formed in California as a bureau of reliable information for investors and others. This association gets daily reports from the districts, tabulates them into a report, and ascertains the most improved machinery for producing oil, and for using oil for steam and other purposes. It furnishes an expert in oil lands and machinery. The association which is meant to be a father to this infant industry is under the guidance of Col. L. P. Crane.

GEOGRAPHICAL EXTENT.

The geographical extent of the oil field, so far as at present known extends along the coast for a width of several miles from Marin and Contra Costa counties southerly to the extreme south of the State. Though oil has been known to exist in California for many years, and seepages in several localities plainly denoted

From the more recent discoveries in Northern and Middle California we turn to the older and better known oil fields of Southern California, experiences met with in their development may be useful to those engaged, or about to engage, on the more recent discoveries.

The principal and most productive oil fields of Southern California are at Los Angeles in the Puente Hills and mountains south of these, known respectively as the Los Angeles, Puente, and Pico oil fields.

The rocks containing the oil are sedimentary, of marine origin and Tertiary age, generally more or less horizontal, except when locally thrown into anticlinal and synclinal folds. The rocks are sandstones, clays, and shales, and outcrops of them are recognized in the streets of Los Angeles by their yellow color.

A white diatomaceous or infusorial earth rock also exists in the same formation. Wells penetrating these formations find the sandy shales, with depth to be bituminous, and more or less soaked with oil. Some of the wells have yielded gas as well as oil. The presence of boring shells in these rocks prove their marine origin. For many years oil was suspected from the quantity of "brea" or oil soaked "float" rock found on the surface, which was used as fuel.

To follow up in detail the evolution of the Los Angeles oil field from its first trial well to the present forest of derricks that now occupies what was once the most fashionable portion of the city, would be quite interesting if space allowed it, but we must turn to Mr. Richardson's able article contributed to the Los Angeles Times for a knowledge of the field as well as to Prof. W. L. Watt's report on this as well as on other fields in Southern California.

The discovery of petroleum in Los Angeles was, in many respects, one of the most important incidents in the history of the city. By discovery is meant the date when the development of oil within the city limits began to assume the proportions of an industry. As far back as 1857 a well was put down on North Spring Street, near Franklin Street, but after going down 800 feet, work on it was suspended. About the same time a well was sunk at Main and Requena streets and drilled to a depth of 900 feet, when it was abandoned. The Union Oil Company also expended at different times and in different places a considerable sum of money in its efforts to find oil in paying quantities.

It was not however, until August, 1893, that oil was found in paying quantities in a well put down near the junction of West State Street and Lakeshore Avenue. At a depth of 150 feet the well showed a yield of two barrels a day, and as it was selling for \$2 a barrel, further work was vigorously prosecuted. Since that date the increase in production has been so great that the total production of the Los Angeles field alone, up to the end of the year 1898, exceeded 5,100,000 barrels.

Starting from August, 1893, the date when the oil industry of Los Angeles began its history, the production of each year has been as follows: In 1893, 100,000 barrels; 1894, 400,000; 1895, 900,000; 1896, 1,200,000; 1897, 1,400,000; 1898, 1,100,000; total, 5,100,000 barrels. During that period prices have ranged from 30 cents a barrel to \$1.65 a barrel, in the field. The minimum price was reached in May, 1895, and the maximum price in March, 1897. The average price per barrel was \$1.

From August, 1893, to December 31, 1898, the average price of oil at the wells was about 65 cents a barrel. The average cost of a well is \$2,300, making the total amount expended for the 1,020 wells put down \$2,346,000. The average monthly cost for the maintenance of a well is \$50, so that the wells now being pumped necessitate the disbursement of about \$30,000 a month for wages and incidentals. The average Los Angeles oil is about fourteen and a half gravity.

During the first half of the year 1898 the average production of the Los Angeles field was 4,000 barrels a day. During the last half of that year the average production was about 2,800 barrels a day.

A peculiarity worthy of note in respect to the Los Angeles oil field is the comparatively small proportion of dry wells, and of wells that did not give a paying yield. During 1895, when prices broke to 30 cents a barrel, a number of the smaller wells were shut down, simply because it did not pay to pump them, with oil at 30 cents a barrel. But under normal conditions such wells would not have been classed as non-payers, and would not have been shut down. Some of these wells are now being reopened and are being sunk to a greater depth with good results.

The Puente oil fields are in Los Angeles County, and about 5 miles distant from Puente Station, on the Southern Pacific Railway. Prof. W. L. Watts in his report on them to the State Mining Bureau, says "the hills in which the Puente oil wells are situated appear to be an east extension of a line of elevation which can be traced in a southeasterly direction from the city of Los Angeles. These hills, as seen at the Puente oil wells, are formed by a series of closely-compressed folds in the rocky formation, which have an east and west trend. At the base of these hills

soft sandstones and conglomerates are found, and in some places a white, chalk-like, diatomaceous rock, similar to that seen at Los Angeles, alternates with reddish-brown sandy strata, forming parti-colored banks, in which the strata vary from a few inches to less than an inch in thickness."

The Union Oil Company of Santa Paula handles the bulk of the oil produced in Ventura County, and the greater portion of it is shipped by them to Olean, near San Francisco, where it is refined. The company has an elaborate pipe-line system, connecting Ventura with their different oil fields in the county, and the oil is either carried by gravity or pumped to the wharf at Ventura, where it is loaded on their tank steamer. Their pipe-line system is over 100 miles in length. The deepest wells in the State are those sunk by the Union Oil Company in Ventura County.

In Santa Barbara County the principal oil wells are at or near Summerland. The Summerland oil is a heavy oil, more closely resembling the Los Angeles oil than that found in any other part of Southern California. The beach wells of Santa Barbara are situated on the ocean beach below high-tide mark, and are the only beach wells known. They have proven themselves good producers, and new wells are steadily going down. A peculiarity of these Summerland wells is the comparatively shallow depth at which natural gas is encountered, and in such abundant quantities as to furnish enough for partial lighting purposes.

The one thing which did more than anything else to place the oil business of Los Angeles on a good footing was the organization of the Oil Producers' Trustees. When the tanks in the field were loaded up, and it was not known how to profitably market the steadily increasing production, some of the largest producers got together and discussed the situation. The result of their deliberations was the formation of the Oil Producers' Trustees, the immediate objects of which were to withdraw as much oil as possible from the field, place it in storage, and market it at the best possible rates, and in this way do away with the cutting of prices. In order to provide sufficient storage capacity, the Oil Storage and Transportation Company, of Los Angeles, was founded. That company constructed four iron tanks, having a combined capacity of 140,000 barrels. By that means the pressure on the tanks in the field has been kept relieved, and the oil has been held for sale at the highest market rates. How thoroughly successful the trustees were in their plans is best shown by the fact that whereas in 1898 oil was freely offered in the field at 60 cents a barrel, with no buyers, it was at the close of the year firm and in good demand at \$1 a barrel.

The Oil Producers' Trustees went out of existence, as an organization, with the close of the year 1898, but the work they were engaged in will be practically continued by the Oil Storage and Transportation Company, which has entered into contracts with a number of the large producers, by which the company will act as the agent of the producers, storing their oil on rates agreed upon and selling it for account of the producers.

In Ventura County is the Sespe and Devil's Gate oil field. The Sespe is in a recent Tertiary formation of sandstones mingled with shales, bleached by the action of gas.

Springs of warm water and petroleum exude from fault fissures in the cliffs of sandstone. Several of the wells struck in this region spouted for a long while high above the derricks. These districts are characterized by compressive movements or crushing of the strata, into anticlinal folds, accompanied by faults and fissures, from which springs of sulphureted water, gas, and oil emanate. In these districts also, and particularly at Sulphur Mountain are evidences of past and still latent solfataric action which has bleached the rocks in the vicinity and deposited alum, sulphur, and gypsum. Below the solfataric line is, at times, a fringe of oil seepages from which heavy oil and maltha creep slowly down the mountain. The oil springs are reached by tunnels driven into the mountain.

These tunnels are below the solfataric line which may mark a line of fissure. The oil in the tunnels is found oozing from little fissures or cracks in the shale accompanied by sulphureted water.

From Santa Paula the bleached shale can be traced from the Sulphur Mountains to the Canada del Laga in which ranch in the Brea Cañon, is the Weldon asphalt mine. We may here note the intimate connection there appears to be in California between asphalt and petroleum. Active solfataric action is observed in these bluffs; the rocks being perceptibly warm. A temperature in one of the tunnels is 130° F., and the shales are burnt into a sort of red porcelain. The shales contain finely disseminated bitumen, mingled with marine diatoms, and the bleached shales are fissured and filled with bitumen.

In the Silver Thread districts are the Sisar and Asphalt Co.'s well. These wells are on a mountain slope, and between the wells and Sisar Creek, numerous springs of oil occur in two belts. When the oil first exudes from the rocks it spreads out in pools of tar, soon thickening into a viscous bitumen which crawls down to Sisar Creek in streams of maltha and impure asphaltum. Some

of the numerous oil wells reach a depth of 2,700 feet producing with a heavy black oil, a brown oil and a green oil. Gushers of both gas and oil, or both combined are met with.

As to the geological horizon of the oil strata of Southern California: At Los Angeles the oil-bearing strata are of Pliocene age; at the Puente field, the rocks are older. In Ventura County the oil sands are at two different horizons; the uppermost is in a formation of shales, traversed by thin strata of bituminous limestone and sandstone of Oligocene age. The second or lower is Eocene and separated from the higher by a thickness of several thousand feet of rocks, consisting of sandstone conglomerates and shales. In Santa Barbara County, Eocene formations show also two oil horizons widely separated.

At Los Angeles the petroleum-yielding rocks form an oil line far down the slope of an ill-defined anticlinal fold, and oil in the other districts is mostly associated with anticlines, the crushed strata of which aid the migration of petroleum from lower to higher oil sands.

As to the remote origin of the oil and bituminous matter of this region we think they are confirmatory of the now pretty well acknowledged theory that the oil comes from the organic matter both vegetable and animal of the ancient seas, distilled it may be and brought near the surface by metamorphic heat. The strata in which these deposits occur are all notably of marine origin, and in this region are much folded, crushed, and disturbed.

For the distillation of the oil from the impregnated strata and infiltration into fissures, the observed solfataric action, as well as the crushed character of the anticlinal strata are significant. It is also significant that in most cases, both in Southern and Northern California, the oil and gas are found in the axes of anticlines. The same is the case in the oil fields of Wyoming, and in some of the Eastern States. The compression which forced the strata up into anticlines, or arches, seems to have had a hydrostatic influence in forcing the oil also up into these anticlines.

In oil fields there are primary deposits and secondary deposits of oil or hydrocarbons. The primary deposit is contained by the rocks in which the petroleum was formed or originally accumulated. The secondary deposits are rocks saturated with petroleum which by means of fissures or other channels has found its way from primary deposits. In this region the Oligocene formations contain a primary deposit of petroleum. This deposit is in the lower portion of a bed of dark colored shales and in certain strata of sandstone immediately underlying these shales. The Eocene Tertiary formations also contain primary deposits of petroleum. The deposit of bituminous sand at Las Conchas on the sea coast of Santa Barbara County is a typical example of a secondary deposit of petroleum.

Petroleum of the Eastern States is composed principally of hydrocarbons of the paraffin series, California petroleum principally of hydrocarbons containing a greater percentage of carbon than do the corresponding members of the paraffin series. The excess of carbon causes the difficulties in manufacturing from the California petroleum illuminating oils which can successfully compete with illuminating oil manufactured from Eastern petroleum. Although only a small portion of the California petroleum is available for illuminating oil it can be resolved into other commodities, such as naphtha gas distillate, lubricating oil, asphaltum, and principally an excellent fuel. From two and one-half to four barrels of crude petroleum may be taken as the equivalent of 1 ton of good coal, the ratio of value differing according to condition under which the petroleum is burned.

For our knowledge of the oil fields of California we are largely indebted to able articles in the Mining and Engineering Review, of San Francisco, to the Los Angeles Times, and to the reports of Mr. W. L. Watts, of the California Mining Bureau.

American Institute of Mining Engineers.

The eighty-first meeting of the Institute will be held at the City of Mexico early in November, 1901. Particulars as to sessions, etc., will be issued later. In connection with the meeting, excursions will be made to many points of interest in Mexico.

Mr. Theodore Dwight, 99 John St., New York City (outside of his official duties as Assistant Treasurer of the Institute), has undertaken to organize, for a limited number of members and guests from the United States, an excursion party, going and returning by special train. For the arrangements of this party Mr. Dwight is personally responsible, and all communications on the subject should be addressed to him in accordance with a special circular which has been issued.

Early notice should be given to Dr. R. W. Raymond, Secretary, 99 John St., New York, of all papers offered for this meeting; and the manuscript of any paper accepted should be in his hands not later than July 1. It is desired to translate, and publish in both Spanish and English, as many as possible of the papers specially pertinent to the meeting.

Mine and Mill Telephones.

Next in importance to labor-saving appliances, if not of prime importance, is the saving of time of officials in mines and mills. This saving of time of the higher-priced men employed at mines can be largely secured by the adoption of a system of communicating verbally between various points of the mining property; and, by such a system, time is not only saved, but efficiency is also greatly enhanced. A proper telephone system is just as convenient and efficient for mine and mill use as for any other purpose. Such a system, especially adapted for mine use, and arranged to fully meet the requirements, is now available at reasonable cost. It is durably constructed and entails little or no trouble and expense to keep in working order. The telephone is like any other machine or tool. If it is purchased from a reliable maker, and one who can show that his instruments and system are in successful operation, there is no doubt of the efficiency and convenience secured. Like all other good instruments, a telephone must be cared for and kept in good condition in order to do good work. The most important portions of its care are its installation and protection.

In the manufacture and installation of mine telephones, experience counts for much, and attention to details is very important. The Ericsson Telephone Co., of 296 Broadway, New York City, two of whose instruments are shown in Figs. 1 and 2, has had years of experience in the manufacture and installation of isolated telephone plants, and there are a number of Ericsson telephones in successful mining operation. The quality of the instruments is such that the United States Government has recently adopted Ericsson phones for the use of the signal corps in the Philippine Islands. This company supplies instruments for intercommunicating purposes, the instruments made with lever, plug or automatic switches, using the hand or small watch-case receiver and transmitter, Fig. 1, or combined receiver and transmitter, Fig. 2. For large mining and milling plants where a number of telephones are desired, all batteries may be placed together, and the phones can be arranged to call automatically by taking the receiver from the hook. Also, if desired, they can be supplied with apparatus for calling in the usual manner by turning a crank, either for intercommunicating use or with a central switchboard.

The Ericsson Co. has not only installed a number of telephones successfully in mines, but has made an enviable record in installing systems in shops and factories, hotels, offices, and exchanges, and it furnishes the instruments and adapts the system to any requirements and for any use desired. Its record of installations shows a great variety of orders both in the United States and Canada, Mexico, South America, South Africa, Hawaii, the Philippines and to far-away Siberia.

The limitations of the speaking-tube system generally used at mines, are such as to make desirable the use of telephones, particularly in large plants. Many mine managers have realized this ever since the telephone has been perfected and used commercially, but have hesitated to take the matter up, owing to the fact that they were not familiar with a system capable of standing mine usage. The Ericsson Co., with its phones and system, has met the hard requirements of mine service, and by writing to the company, full particulars and information can be obtained.



FIG. 1.

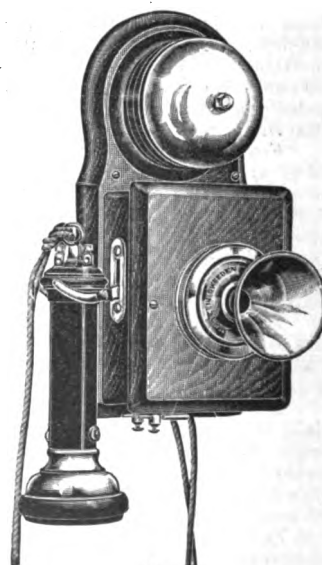


FIG. 2.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Mine Foremen's Examination for the 6th, 8th, and 10th Bituminous Districts, Held at Johnstown, Philipsburg, and Altoona, Pa., January 2d, 3d, and 4th, 1901.

PRELIMINARY QUESTIONS.

(A) Are you a citizen of this Commonwealth? What is your age?

(B) If a naturalized citizen produce proof of your citizenship.

(C) How many years practical experience have you had in the workings of bituminous coal mines in this State?

(D) State when, at what mines, by whom employed, and in what capacity you have had practical experience in mining in the bituminous mines of this State.

(E) Have you testimonials of character?

(F) What are the lawful duties of a mine foreman and other mine officials?

Ans.—The lawful duties of a mine foreman are fully stated in reply to Ques. 4, page 424, MINES AND MINERALS, April, 1901. The duties of a mine superintendent, though more general and supervisory, are similar to those of the mine foreman, who often acts in his place, as required by Section 2 of Article 7 of the Bituminous Mine Law. The duties of the fire boss are explained in answer to question F of the Fire Boss Examination, following, on page 473.

(G) What are the legal requirements with reference to the construction of air bridges in mines, and are the requirements the same under all conditions?

Ans.—Article 4, Section 3, requires that all overcasts or air bridges shall be constructed of masonry or other incombustible material of ample strength, or be driven through the solid strata. These requirements apply only to such air bridges as were or shall be constructed after the passage of the Act (approved May 15, 1893), and "in mines generating firedamp in sufficient quantities to be detected by ordinary safety lamps."

Ques. 1.—State briefly what would guide you in determining the best system of mining a seam of coal looking to safety and economy in doing so.

Ans.—The following considerations assist in determining the system of mining best adapted to a given seam. (1) Depth, (2) Thickness, (3) Inclination of the seam, (4) Character of the coal, and nature of the overlying and underlying strata, (5) The gaseous condition of the seam. (See Coal and Metal Miners' Pocket-book, Sixth Edition, page 279).

Ques. 2.—What are the important factors necessary to insure good ventilation at the face of the mine and not get too high a water gauge, providing the quantity entering the mine is fully adequate?

Ans.—The ventilation of the working face is made more efficient and satisfactory when the current is divided into separate splits. Purer air is supplied directly to the working face, and the return current laden with smoke and gas from one section of the mine is not required to pass through another section, but is conducted directly to the main return current. Greater safety is also obtained in the splitting of the air, since an explosion occurring in one section of the mine is more often confined to that section, instead of being transmitted to the other working places in the mine.

Ques. 3.—Find the number of square feet of rubbing surface in the following airways: (a) 4 feet high, 9 feet wide, and 6,000 feet long; (b) 6 feet high, 6 feet wide, and 6,500 feet long. With the same power used in each, what difference would there be in the quantity of air passing? Give reasons.

Ans.—

(a) Rubbing surface = $2(4 + 9) \times 6,000 = 156,000$ sq. ft.,
area = $4 \times 9 = 36$ sq. ft.

(b) Rubbing surface = $2(6 + 6) \times 6,500 = 156,000$ sq. ft.,
area = $6 \times 6 = 36$ sq. ft.

Applying the same power to each of these airways there would be no difference in the circulation produced in either case. This

is evident from the formula expressing the quantity of air (q) which a given power (u) will produce against a mine potential X_u .

$$q = X_u \sqrt[3]{u}.$$

in which

$$X_u = \frac{a}{\sqrt[3]{ks}}$$

The power applied and the potential being constant, the quantity in circulation is constant. See The Coal and Metal Miners' Pocket-book, Sixth Edition, page 371.

Ques. 4.—What are the causes of blown-out shots and what dangers arise therefrom, and how would you avoid them?

Ans.—See Ques. 11, page 327, MINES AND MINERALS, February, 1901.

The danger from windy or blown-out shots arises, particularly in dusty mines, or in workings where there is a large accumulation of fine coal and dust at the working face. These "fines" should be loaded out with the coal, and not allowed to accumulate at the face of the workings. The fine dust is blown into the air by the force of a blown-out shot, and being acted upon by the flame of the blast distills a large amount of carbonic oxide gas (CO), which extends the explosion through the mine workings. The extent of such an explosion will depend wholly upon the condition of the workings, with respect to the accumulation of dust and fine coal, the quantity of air in circulation, and to some extent upon the quantity of carbonic acid gas or blackdamp present. Carbonic acid gas (CO_2), in presence of the incandescent carbon, in a mine explosion, is converted into carbonic oxide gas or whitedamp (CO), which transmits and adds to the force of the explosion. Under certain conditions, however, the quantity of blackdamp (CO_2) may be such as to extinguish the flame of the explosion and render the firedamp in explosive.

Ques. 5.—If a water gauge of 1.5 inches produces 95,000 cubic feet of air per minute, how much would a water gauge of 2 inches produce, and what would be the horsepower from the increased water gauge, and quantity?

Ans.—In the same airway the quantity of air in circulation will be proportional to the square root of the pressure producing the circulation or the square root of the resulting water gauge.

Thus, $\sqrt{1.5} : \sqrt{2} :: 95,000 : x$, or $x = \sqrt{\frac{2}{1.5}} \times 95,000 = 109,695$ cu. ft. per min. The power required for the circulation increases in the ratio of the cube root of the power to the square root of the pressure. Calling the power producing a 1.5-inch water gauge 1, the power required to produce a 2-inch water gauge would be

$$\sqrt{1.5} : \sqrt{2} :: \sqrt[3]{1} : \sqrt[3]{x},$$

or,

$$x = \sqrt{\left(\frac{2}{1.5}\right)^3} = 1.54 \text{ h. p.}$$

Hence, the increase of power is as 1:1.54, when the increase of water gauge is as 1.5:2.

Ques. 6.—What would cause you to turn off rooms at 45 degrees instead of at right angles to the main heading?

Ans.—(a) When the inclination of the seam is such that it becomes necessary to drive the rooms across the pitch in order to lessen the grade of the roads in the rooms and allow the car to be taken to the working face. (b) When the conditions are such that the coal breaks better when worked half on.

Ques. 7.—If you have a set of broken timbers in your drift, how would you proceed to repair them?

Ans.—The condition of the roof should be carefully examined before the broken timbers are disturbed or removed. It may be advisable to take down considerable of the roof in question if the same has become "heavy"; or it may be necessary, if the roof is not to be taken down, to place an extra set of timbers at the side of the broken set before removing the latter, or new sets may be placed upon each side of the broken set. When this has been done the broken timbers are carefully removed. [In replacing a set of broken timbers it should be sought to ascertain, if possible, the cause of the breaking by carefully observing the timbers. It may be that the roof pressure was brought to operate too heavily upon the center of the collar by wedging at that point, as shown in a, Fig. 1. In wedging a set of timbers, care should be taken to drive the wedges so that the roof pressure will be evenly distributed. Wedges should never be driven over the center of the collar but on each side, as shown in b, Fig. 1. The joints of the timbers

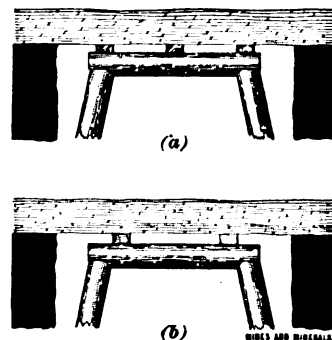


FIG. 1.

forming the set should be carefully made to fit each other; the legs of the set should have a spread of 2 inches for each foot of height, and the joints should be carefully cut as shown in Fig. 1.]

Ques. 8.—What are the causes of the numerous accidents in coal mines, and what would you suggest to avoid them?

Ans.—See MINES AND MINERALS, Ques. 19, page 233, December, 1900, and Ques. 8, page 425, April, 1901.

Ques. 9.—What are the necessary supplies that should always be on hand at the mine for the safe working of the same, and what is your duty in the case when your supplies are not on hand when needed?

Ans.—There should always be on hand an abundant supply of timber of the size and kind required in the mine; also, all other needed supplies such as boards, brattice cloth, spikes, ties, tracking, rails, nails, tools, iron, and other material necessary for making repairs. There should be also maintained at the mouth of every pit such material as would be of use, in case of accident, for the treatment of burns, bruises, broken limbs, etc., as for example, bandages, splints, linen, boiled oil, or olive oil, as well as stretchers, woolen and waterproof blankets, and ambulance. (Bituminous Mine Law, Article 18, Section 1.) When such supplies are not kept at the mouth of the mine in sufficient quantity, it is the duty of the mine foreman to withdraw the men until they are obtained. (Bituminous Mine Law, Article 7, Sections 1 and 2.)

Ques. 10.—How do mine fires originate, and what precautions are necessary to prevent them?

Ans.—Mine fires may originate as the result of carelessness in the use of naked lamps, whereby timber, brattice cloth, powder, hay, etc. become ignited; or a gas feeder may be ignited by the flame of a blast; or the fire may be the result of spontaneous combustion taking place in the gob. In the first case more care is required in the use of naked lamps and in the handling of material. In the second case, where the presence of gas feeders are suspected in the coal or adjacent strata, means should be adopted to prevent the flaming of a blast, by the use of either flameless powders or detonating explosives, or by means of the water cartridge often employed for this purpose. When the fire originates from spontaneous combustion in the gob it will be necessary to observe the precautions mentioned in answer to Ques. 7, page 425, MINES AND MINERALS, April, 1901.

Ques. 11.—If you have a pump 14 inches in diameter, 36-inch stroke, with 100 feet per minute velocity of water in a 10-inch suction pipe, how many gallons of water will be delivered per hour?

Ans.—The question as stated is rather blind. We assume that what it is intended to say is that the velocity of the pump or the piston speed of the pump is 100 feet per minute. In this case the quantity of water delivered (gal. per hr.), assuming that the pump is double acting and the water end has an efficiency of 85 per cent., is

$$G = 60 \times \frac{.85 (.7854 d^2 S \times 12)}{231}$$

And substituting values in this equation, we have,

$$G = 60 \times \frac{.85 (.7854 \times 14^2 \times 100 \times 12)}{231} = 40,784 \text{ gal. per hr.}$$

On the other hand, if as the question states, the velocity of the water in the 10-inch suction pipe is 100 feet per minute, the quantity of water delivered (gal. per hr.) would be,

$$G = 60 \times \frac{.7854 \times 10^2 \times 100 \times 12}{231} = 24,480 \text{ gal. per hr.}$$

The length of stroke of the pump (36") is not essential to the question when the piston speed of the pump is given.

Ques. 12.—What are the dangers attending the use of electricity in mines, and what means should be adopted to prevent such dangers?

Ans.—See Ques. 17, page 426, MINES AND MINERALS, April, 1901.

Ques. 13.—A current of air entering the mine is 32,000 cubic feet at the inlet, and 34,000 cubic feet at the outlet, what is the cause of the increased quantity?

Ans.—The increase of quantity may be due to either one or both of two causes. (a) The increase of temperature of the air current in passing through the mine, (b) the diffusion of mine gases into the air current.

Ques. 14.—An anemometer registers 30,000 feet velocity per hour in an airway 8 ft. $\times$ 5 ft., what would be the volume of air passing per minute, and how would you determine if the anemometer was in good working order?

Ans.—The quantity of air passing per minute in this airway, assuming that the anemometer has registered an average velocity for the airway, would be

$$\frac{30,000}{60} \times 8 \times 5 = 20,000 \text{ cu. ft. per min.}$$

The testing of the anemometer is always attended to by the instrument maker, and cannot be properly done without the right

means to accomplish this end. Resort may be had to the flash test for determining approximately the velocity of the air current; but in this experiment the smoke of the flash is borne upon the swiftest portion of the air current flowing in the center of the airway. This central velocity of the air current is considerably above the average velocity. In applying such a test for the purpose of checking the accuracy of the anemometer, the instrument should be held in the center of the airway during the entire time. Care must be taken not to obstruct the area of the airway with the body of the observer. The stop that throws the registering apparatus into gear must be operated at the moment that the flash is observed, and at the first smell of the powder in the air current, or at its first appearance at the anemometer, the registering apparatus must be promptly thrown out of gear. The difference of readings in the anemometer or the amount the anemometer registers should correspond to the distance from the flash to the instrument. The small interval of time lost on account of the personal equation of the observer would perhaps be offset by the disturbance of the current at the point where the flash is fired.

Ques. 15.—What size square ditch running full of water at a velocity of 5 feet per second will deliver 675 gallons per minute?

Ans.—Since the ditch is square the depth of the water will be equal to the width of the ditch, and calling this depth of water or width of ditch x , we have

$$x = \sqrt{\frac{675 \times 231}{60 \times 5 \times 12}} = 6.58 \text{ in.}$$

Ques. 16.—What are the different instruments necessary for the use of a mine foreman to run a mine as required by law and for his employer's interest, and what are their uses?

Ans.—In addition to all of the instruments named and described in answer to Ques. 8, page 428, MINES AND MINERALS, April, 1901, the mine foreman should also be provided with a compass for the purpose of surveying small portions of the working places or giving sights for the driving of entries or rooms. While the regular mine survey is or should always be made with a transit by an engineer, the use of the compass is important in the giving of sights or bearings in entries and rooms, and this work usually devolves upon the mine foreman or upon his assistant.

Ques. 17.—A heading is driven 560 yards at \$1.85 per yard; crosscuts are driven every 20 yards, and are 8 yards long, at 40 cents per yard; the drain is 15 cents per foot, what is the total cost of driving such a heading?

Ans.—

Entry driving.....	560 $\times$ \$1.85	= \$1,036.00
Crosscuts	560 20 $\times$ 8 $\times$.40	= 99.60
Drain	560 $\times$ 3 $\times$.15	= 252.00
Total cost		\$1,387.60

Ques. 18.—If you had charge of a mine and the fan engine suddenly broke down, what would you expect to be the condition of the ventilation, and how would you continue to run the mine the rest of the day?

Ans.—The condition of the mine with respect to ventilation in this case would depend upon the amount of ventilation that was produced in the mine by natural causes or by other artificial means. If the fan mentioned was the only means of ventilation, and the natural motive column existing in the shaft or in the slope was very small and of no practical effect, the breaking down of the fan would result shortly in a complete stoppage of ventilation in the mine. Under these conditions whether the mine were gaseous or not the stoppage of the fan would be quickly followed by the men quitting their work. Article 20, Rule 6, of the Bituminous Mine Law, makes it the duty of the mine foreman to order the men to immediately withdraw from the mine. The rule reads as follows:

Rule 6.—In case of accident to a ventilating fan, or its machinery, or to the fan itself whereby the ventilation of the mine would be seriously interrupted, it shall be his (mine foreman's) duty to order the men to immediately withdraw from the mine and not allow their return to their work until the ventilation has been restored and the mine has been thoroughly examined by him, or his assistant and reported to be safe.

Ques. 19.—There is a shaft 50 feet deep on a hillside, with a creek 100 feet below the level of the bottom of the shaft, and 500 feet away; could you remove the water with a siphon? Explain fully the principle of a siphon.

Ans.—A siphon could not be used to lift the water the entire depth of this shaft. In order to employ a siphon here a tunnel or rock slope would have to be driven from the shaft, at a point, say not higher than 24 feet above the bottom of the sump, out to the ravine, through which to lay the siphon pipe, since the theoretical lift of a siphon at sea level is only 34 feet, and in practice a siphon will not give good results if the vertical lift much exceeds 24 feet, and a shorter lift than this will give better results. See Prize Contest Ques. 636, page 314, MINES AND MINERALS, February, 1901. The principle of the siphon is the same as that of the

barometer; the weight of the atmosphere pressing upon the surface of the water in the sump or supply basin forces the water up the shorter leg of the siphon. The vertical height that the atmospheric pressure forces the water is called the lift of the siphon, and, as stated above, should not exceed in practice 24 feet at sea level, although short vertical lifts sometimes reach 28 and 28 feet. As the height above sea level increases, the atmospheric pressure decreases, and as a consequence the lift of the siphon is decreased. There are other factors also affecting the successful working of a siphon, an important point in long siphons being that the fall of the siphon, or the vertical height of the summit of the siphon above the discharge basin, shall sustain a certain relation to the ratio existing between the lengths of the two arms of the siphon and the theoretical and actual lifts. This relation is expressed by the following equation:

$$\begin{aligned} \text{Let } h &= \text{lift of the siphon,} \\ h_1 &= \text{fall of the siphon,} \\ l &= \text{length of the short arm,} \\ l_1 &= \text{length of the long arm.} \end{aligned}$$

$$\text{Then, } h_1 = \frac{l}{l_1} (34 - h) + 34.$$

This equation applies to siphons at sea level when the theoretical height of the water column due to the atmospheric pressure is 34 feet. (See article, Can A Siphon Have Too Much Fall? page 474, MINES AND MINERALS, May, 1900.) At elevations above or below sea level, the theoretical water column for such elevation must be substituted for 34 (See Coal and Metal Miners' Pocketbook, Sixth Edition, page 340, for method of calculating such water column, etc.).

Ques. 20.—What system would you adopt to keep a constant current of air flowing through the mine so as to prevent an accumulation of gas, and keep the mine in a safe, healthy condition?

Ans.—The circulation in the mine should be independent, as far as possible, of doors and regulators. If the latter are used they should be provided with a suitable lock to prevent their being tampered with and the circulation deranged. Wherever doors are used there is the liability that these will be set open at any time and carelessly left in this position, which would result in a serious derangement of the circulation. To avoid the use of doors, overcasts must be built at the mouth of each pair of cross-entries to conduct the return or the intake current, as the case may be, across the other entry or airway. Each pair of cross-entries thus forms a separate district of the mine with respect to ventilation, and a reliable circulation of air is thereby provided. Also, the ventilating apparatus should be in duplicate. There should always be a reserve fan and engine at a gaseous mine.

Ques. 21.—Describe the different systems of mine haulage. What are the most favorable conditions for each system?

Ans.—The systems of haulage used in mining practice, besides mule haulage, may be classed as *motor* and *rope haulage*. Motor haulage may be divided as follows: Haulage by compressed air, by electricity, and by steam and gas engines. In each of these, special motors are used as locomotives, and are taken into the mine. Of these motors, those run by compressed air supply fresh air to the mine workings, and give off no noxious gases. The electric motor possesses the disadvantage of entailing the risk of the ignition of mine gases, from the sparking of the motor, and is therefore not adapted to use in gaseous workings. The steam motor and gas engine possess the disadvantage of giving off noxious gases and a large quantity of exhaust steam which tends to rot the timbers, and is otherwise a nuisance, in mine airways. Motors are particularly adapted to haulage in mines having variable grades. There are two general types or systems of rope haulage. (a) Endless-rope system. (b) Tail-rope system. Besides these may be mentioned, as special cases, the inclined or gravity-plane and the engine-plane systems. These latter are adapted only to haulage upon steep inclines, or where the weight of the empty cars descending may be made to balance a part of the weight of the ascending loaded cars. The endless-rope system is adapted to large outputs, under a good roof, or a double system of haulways. In this system, it is always preferable to maintain a double-track system, either in a single wide entry, or in two entries. The tail-rope system is adapted to smaller outputs and to variable grades, and where the conditions would not permit of the working of the endless-rope system. (See The Coal and Metal Miners' Pocketbook, Sixth Edition, page 398.)

Fire Bosses' Examination for the 6th, 8th, and 10th Bituminous Districts, Held at Johnstown, Philipsburg, and Altoona, Pa., January 4th, 1901.

PRELIMINARY QUESTIONS.

(A) Are you a citizen of this commonwealth? What is your age?

(B) If a naturalized citizen produce proof of your citizenship.

(C) How many years practical experience have you had in the workings of bituminous coal mines in this State?

(D) Have you testimonials of character?

(E) Have you had any experience in mines in this country generating explosive gases? If so, state in detail the character of such experience, the length of time employed, the nature of employment at each mine where so employed, giving names of mines and employers.

(F) What are the legal duties of a fire boss?

Ans.—The legal duties of a fire boss are given in General Rules 9, 10, and 11 of Article 20 of the Bituminous Mine Law of Pennsylvania as follows:

Rule 9.—He shall enter the mine before the men have entered it, and before proceeding to examine the same he shall see that the air current is traveling in its proper course, and if all seems right he shall proceed to examine the workings.

Rule 10.—He shall not allow any person, except those duly authorized, to enter or examine in any part of the mine through which a dangerous accumulation of gas is being passed in the ventilating current from any other part of the mine.

Rule 11.—He shall frequently examine the edges and accessible parts of new falls and old gobs and air-courses, and he shall report at once any violation of this act to the mine foreman.

Article 6, Section 8, of the Bituminous Mine Law also requires that the fire boss shall make a record of the examination of the mine immediately upon his return to the surface, in a book provided for that purpose by the mine inspector and kept at the mine. Such record must clearly state the nature and location of any danger which he may have discovered in the examination of the mine, and must be signed by the fire boss in person. The fire boss must also make a verbal report to the mine foreman after each examination and acquaint him with any dangerous places he may have found during his examination of the mine. (See answer to Ques. 17, page 429; MINES AND MINERALS, April, 1901.)

Ques. 1.—Name and describe the explosive gases found in coal mines, giving their names, symbols, specific gravities, properties, and general characteristics. Where are they found, and how can they be eliminated from the mines?

Ans.—The so-called explosive gases of coal mines are marsh gas (CH_4), carbonic oxide gas (CO), and sulphureted hydrogen gas (H_2S). These gases have been described fully in answer to Ques. 5, page 230, Dec., 1900; and Ques. 22, page 378, March, 1901, MINES AND MINERALS.

Gas is not always found in quantity in that portion of the mine where it is being generated; the lighter gases, marsh gas and carbonic oxide gas, owing to their low specific gravity, tend to rise and therefore accumulate at the roof and the higher portions of the mine workings, while sulphureted hydrogen gas, which has a specific gravity greater than that of air, accumulates near the floor and in the lower portions of the workings. In order to remove mine gases from the workings it is necessary to maintain a current of a sufficient velocity to sweep them from the cavities and lurking places in which they accumulate. It is also necessary that the current be well directed, and be so conducted as to sweep the entire working face.

Ques. 2.—What constitutes firedamp, and what gaseous mixtures does it include?

Ans.—The term "firedamp" generally means any mixture of mine gases and air in explosive proportions, although the term is applied differently in different localities. See answer to Ques. 23, page 379, MINES AND MINERALS, March, 1901. The gases usually present in firedamp mixtures are marsh gas and smaller proportions of the heavier hydrocarbons, such as olefiant gas (C_2H_4), ethane (C_2H_6) etc. There is always present a variable quantity of carbonic acid gas (CO_2) and at times small quantities of hydrogen (H), and carbonic oxide gas (CO).

Ques. 3.—Why does an explosion of firedamp in a mine render the air therein dangerous to health and life?

Ans.—The explosion of a body of firedamp in a mine destroys the available oxygen in the air, and the gases which form the resulting afterdamp do not support life. The afterdamp of an explosion always contains a considerable percentage of carbonic oxide gas (CO), which is one of the most violently poisonous gases of the mine. The presence of this gas in the afterdamp is usually unsuspected, because it supports combustion and allows the lamps to burn even more brightly than before. It is, therefore, the most dangerous of all the mine gases.

Ques. 4.—Explain the principle of safety lamps; how are they constructed, and what precautions should be taken in their use in gaseous mines?

Ans.—The principle and construction of safety lamps has been fully explained in answer to Ques. 5, page 379, MINES AND MINERALS, March, 1901. In the use of safety lamps it is always necessary to keep the gauze clean. Care should be taken not to expose an unbonneted lamp to a current of air moving with such a velocity that the flame will be blown toward or through the gauze. The unbonneted Davy is unsafe in a current having a velocity greater than 6 feet per second; the

unbonneted Clanny, in a current having a velocity greater than 8 feet per second. When moving against the current it must be remembered that the effective velocity of the air is equal to the sum of the velocity of the current and the velocity with which the lamp is moving against it. When working in gas it is necessary to carefully observe the safety lamp and to remove it at the first sign of the heating of the gauze. When gas is observed in the lamp, and especially if the lamp fills with flame, it is necessary to lower and remove the lamp with great care and promptness, making no quick movement lest the flame of the gas burning in the lamp be blown through the gauze.

Ques. 5.—In a mine known to give off explosive gas, where mining machines are in use to undercut the coal, and the same has to be blasted down with powder or other explosive, what precautions would you take, and what is liable to occur, even though the safety lamp gives no indication of gas?

Ans.—In the mining of coal with machines there is always produced a considerable quantity of fine coal and dust. When the coal is blasted down, no accumulation of fine coal and dust should be allowed at the working face. The force of the blast throws the fine dust into suspension in the air, and this acted upon by the flame of the shot distills carbonic acid gas and produces what is termed a windy shot. In a dusty mine this may result in a serious mine explosion. Water is often employed to sprinkle the working place in the vicinity of the blast before firing.

Ques. 6.—If you had charge of a gaseous mine what observations should you make in visiting the workmen's places, and what would be requisite to comply with the mining law? State fully.

Ans.—Each working place must be carefully examined to ascertain the presence of any gas and the safety of the roof, and the need of timbering. If gas or other danger is discovered and cannot be quickly removed, it is necessary to fence off the working place or put up a proper danger signal so as to warn any person against entering such place. All such dangerous places must be reported at once to the mine foreman after each examination, and must be recorded in the book kept at the mine for that purpose, immediately after the examination has been made, such record to be signed by the fire boss making the examination. The record must state clearly what dangers have been observed, and where they exist.

Ques. 7.—Explain why some safety lamps are more sensitive to gas than others.

Ans.—The features that render a lamp more sensitive to gas are: (1) A free entry of air and gas into the lamp at a point below the flame. (2) An unobstructed upward draft within the lamp sufficient for the removal of the gases of combustion. (3) The maintaining of a uniform non-luminous flame, such as the hydrogen flame of the Clowes hydrogen lamp, or the alcohol flame of the Pieler lamp, or the naphtha flame of the Wolf lamp. (4) No reflecting surfaces behind the flame. Some safety lamps are more sensitive to gas than others because they embody a larger number of the features mentioned above.

Ques. 8.—If suddenly you found yourself in an explosive mixture of air and gas, state briefly what you would do.

Ans.—The presence of an explosive mixture of air and gas would be made known by the lamp filling with flame. In such a case the lamp should be promptly though cautiously lowered, and at once smothered under the coat or other garment, while the person withdraws as quickly as possible to fresh air. The precaution must be taken to carefully shield the lamp from the force of the current due to its quick removal.

Ques. 9.—If, on going your rounds through pillar workings of a gaseous mine, a miner's safety lamp appears cleaner on your second visit than it did on your first visit, what would you think was wrong, and what would be your duty in such a case?

Ans.—The circumstance would indicate that the miner had cleaned his lamp, and the fact would require an investigation as to how this was done. If sufficient evidence could be obtained that the miner had tampered with the locked fastenings of the lamp, the case should be promptly reported to the mine foreman.

Ques. 10.—If 20,000 cubic feet of air and gas at its most explosive point is passing through the mine, what is the quantity of gas given off, and what quantity of air should be added to render it non-explosive?

Ans.—A firedamp mixture at its most explosive point contains 9.38 per cent. of gas, and 20,000 cubic feet would contain

$$20,000 \times \frac{9.38}{100} = 1,876 \text{ cubic feet of gas.}$$

Firedamp is at its lower explosive limit when the proportion of gas and air is 1:13; that is to say, when there is 13 times as much air as gas the mixture will be feebly explosive. When more air than this is added, or say, when there is 13½ times as much air as gas, the mixture ceases to be explosive. In this case there being 1,876 cubic feet of gas, the quantity of air that will render this gas in explosive,

assuming the gas to be pure marsh gas, would be $1,876 \times 13.5 = 25,326$ cubic feet of air. The quantity of air to be added, therefore, in this case is $25,326 - 20,000 = 5,326$ cu. ft.

Ques. 11.—What particular dangers are there in pillar drawing in a mine giving off explosive gas?

Ans.—The immediate effect of pillar drawing is the more or less rapid settlement of the roof strata, often causing a fall of roof. Assuming that the gas generated in the mine comes from the roof strata, the drawing of the room pillars would result in the disengagement of this gas, which would escape from the crevices of the roof and would be given off in larger quantities when falls of roof occurred. If the gas is contained in the coal there is not the danger that would otherwise be present in pillar drawing, since it would have largely drained off before the pillars were drawn. If the gas is present in the floor or underlying strata, it will be set free when drawing pillars, but not in as large quantities as when present in the roof strata. The pressure of the gas when contained in the overlying strata, often renders the roof slate heavy.

Ques. 12.—Are there any conditions under which the flame will pass through the gauze of a safety lamp? Explain fully.

Ans.—Flame will pass through the gauze of a safety lamp

(1) When the gauze becomes heated. Its power to cool the burning gases below their temperature of ignition is then destroyed. (2) When the lamp is subjected to a current of air sufficient to blow the flame through the gauze. In this case the passage of the flame through the small openings of the gauze is too rapid to cool the burning gas below its temperature of ignition. (3) When the gauze is dirty. In this case, the dirt, smoke, or soot accumulating upon the wires of the gauze becomes a good conductor of heat and the wires are more rapidly heated, which again destroys their power to cool the flame of the burning gas below its point of ignition.

Ques. 13.—In driving entries where large volumes of gas are given off, what precautions would you adopt to insure the safety of the workmen, and how would you prevent an accumulation of gas at the faces of the same?

Ans.—Here, locked safety lamps only should be used, and the volume of air in circulation should be sufficient to dilute and carry off all the gas as fast as it is generated. The current should be well conducted to the face, and in order to accomplish this a brattice should be erected, if necessary, extending from the outbye rib of the last breakthrough and running along one side of the entry toward the face, so as to compel the air current to circulate around the end of the brattice and sweep the face, see Fig. 2. Strict

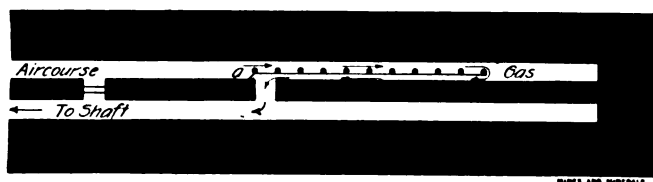


FIG. 2.

regulations should be made and enforced with regard to blasting; each shot should be well cut and mined before it is fired, and care should be taken that the charge is not located on the solid, but is given opportunity to work. Shots should be fired by an experienced miner duly authorized for this work, and only after a careful examination of the face to ascertain that there is no accumulation of gas at that point, and that a sufficient volume of air is passing. No accumulations of fine dust or coal should be allowed at the face of the entries. After the firing of each shot the miners should use great caution in approaching the face to avoid the danger which may exist in case a body of gas has been set free or a gas feeder opened by the blast. Every precaution must be used to secure the roof of the entry, especially when the gas is coming from the roof. In case the gas is issuing from the coal, proper precautions must be taken to avoid falls of rib coal caused by the pressure of the gas.

Ques. 14.—After making your report and returning into the mine, what would you consider your duty as a fire boss?

Ans.—The duty of the fire boss is to visit those places which he may have discovered to be dangerous in his first examination, and to examine the same to ascertain if there is any change in their condition. He should give his particular attention to such places from time to time during the working hours. Always upon entering the mine his first duty should be to assure himself that the air is moving properly upon the intake airway. He should also acquaint himself with the condition of the return current to ascertain if any unusual quantity of gas is being given off in the mine. He should devote his spare time to the examination of the abandoned portions of the mine workings in order to ascertain that there is no large body of gas accumulating in such workings.

He should examine carefully any new falls upon the entries or working places of the mine. While the particular attention of the fire boss should be devoted to the examination of the places previously mentioned, he should, as far as possible, visit every working place in his district, and should observe carefully the condition of the workmen's lamps, the timbering of the places, and the gaseous condition of the current.

Correction.—Attention is called to a misprint in Examination question, page 380 of the March, 1901, issue of MINES AND MINERALS. The question and answer should read as follows:

Ques. 10.—How many cubic feet of marsh gas would require to be generated in a mine per minute to render dangerous a current of 30,000 cubic feet of air per minute?

Ans.—The lowest explosive limit of firedamp is reached when the proportion of gas to air is 1 : 13, and dangerous conditions may be considered as existing when the proportion of gas to air is 1 : 15. Since there are 30,000 cubic feet of air per minute in circulation, a quantity of $\frac{30,000}{15} = 2,000$ cubic feet of gas per

minute, will produce dangerous conditions in the mine. Indeed, a much less quantity of gas than this may be considered dangerous, since under certain conditions explosions may occur when the proportion of gas and air is considerably less than 1 : 15. These conditions are obtained when the firedamp mixture consists of other gases than pure marsh gas; also when coal dust is held in suspension in the atmosphere of the mine. Explosive conditions are often induced by concussion produced by the explosion of a blast, and at times by the sudden closing of a mine door, or other causes, when the percentage of gas present in the current is not within the explosive range. (See, Testing for Gas by Lamp Flame, MINES AND MINERALS, April, 1900, page 429; and Characteristics and Peculiarities of Mine Gases, July, 1900, page 570.)

The Friction of Air Currents in Mines—Mine Resistance.

The movement of one body upon another or the rubbing of one body against another always produces a force that resists the motion of the bodies relatively. This force is called the force of friction, and since it is always a force that resists motion it is likewise spoken of as the frictional resistance due to motion.

In estimating the friction of an air current in the airways of a mine the unit adopted as the starting point is what is called the coefficient of friction. This is the friction produced or the resistance offered by one square foot of rubbing surface to an air current having a velocity of one foot per minute. It may make the subject clearer to the beginner to call this the unit of friction instead of the coefficient of friction. The unit or coefficient of friction is represented in mining formulas by k . Its value has been variously estimated by different investigators, and it is remarkable how these values vary. The most commonly accepted value for the unit of friction in ordinary mines is that given by Atkinson, $k = .000000217$. There is little doubt but that this value represents very closely the frictional resistance common to average mining practice. This value of k must not be understood as relating only to the friction developed between the air current and the rubbing surface of the airway. It is, in truth, the total resistance to passage, reduced to a basis of one square foot of rubbing surface and a velocity of one foot per minute. Its value includes the resistance offered by bends or any usual obstruction in the airway and as such represents types of mining practice as these affect ventilation. The value of the coefficient of friction will, therefore vary in different localities where different methods of mining are practiced and different methods of timbering are employed. In mines where the airways are cleaned regularly, and are straight and unobstructed by timber or otherwise, the value of this coefficient will be less than that given above. This would be especially true also for arched airways lined with brick, presenting practically no obstruction to the flow of the air current. In such cases the value of the coefficient as given by Fairley would be more applicable ($k = .00000001$). This coefficient, however, will not represent accurately the frictional resistance of the average class of airways in American practice.

Having determined the unit of friction or the frictional resistance per square foot of rubbing surface for a velocity of the air current of one foot per minute, to obtain the total friction produced by the passage of any air current through any given airway, we apply the two laws of friction relating to airways.

(1) The friction or resistance of an air current in an airway varies directly as the amount of rubbing surfaces (assuming with close approximation that the mine resistance is proportional to the rubbing surface).

(2) The friction or resistance of an air current in an airway varies directly as the square of the velocity of the current.

Then, applying these laws to obtain the total friction or the total resistance, we multiply the unit of friction by the rubbing

surface (square feet), and that product by the square of the velocity of the current (feet per minute); thus,

$$\text{total resistance} = k s v^2 = k l o v^2,$$

in which k = unit or coefficient of friction (lb.),
 s = amount of rubbing surface (sq. ft.),
 v = velocity of air current (ft. per min.),
 l = length of airway (ft.),
 o = perimeter of airway (ft.).

But, the total pressure producing ventilation is equal to the resistance which it overcomes. This total pressure is equal to the unit of ventilating pressure p multiplied by the sectional area a of the airway. Hence, we write for the total resistance the equation $p a = k s v^2$.

This is the natural resistance of the airway or mine, or the resistance due to the friction of the air in its passage through the mine. We call this the *natural resistance* in distinction from the resistance offered by regulators placed in the airway for the purpose of accomplishing a proportionate division of the air current. The resistance due to regulators will be described in another article.

The White Star Oil Filter.

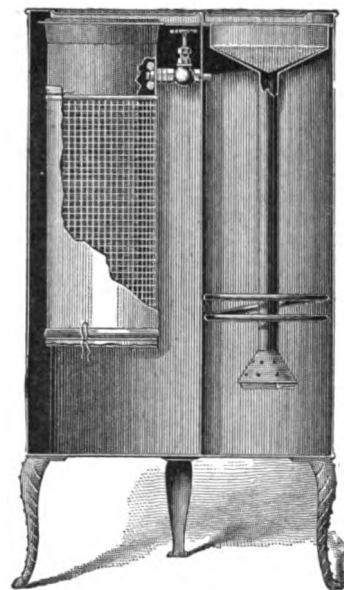
It is almost needless to argue upon the desirability, even necessity, of utilizing the oil that is lost in machinery lubrication by reason of its passing through and becoming filled with grit and dirt. In times past when competition was not so great, and the margin of profit was adequate, such small leaks were regarded as trifling for consideration, but now when profits are a matter of cents rather than dollars, no economy, be it ever so small, is overlooked by the alert and wide-awake manufacturer. The importance, therefore, of saving this waste oil being generally recognized, the question confronting the manufacturer today, is the means of saving—whether it can be so thoroughly, quickly, and cheaply done as to justify him in making use of it.

As is to be supposed, there are devices by the score, good, bad, and indifferent, purporting to purify this waste oil and render it fit for use again. The makers of the White Star oil filter claim that an investigation of its design, construction, storage capacity, complete filtering operation and cleaning process, discloses the fact that it possesses each and every one of the requirements and conditions essential to a complete filter and purifier, and that it not only absolutely purifies the dirty oil, but does it at a minimum of expense, time, and attention. On account of its large storage capacity for both pure and waste oil, it is unnecessary to continually pour in the dirty oil in small quantities and as constantly draw off the purified oil.

The White Star is designed and constructed on unique and original lines. It is divided by a vertical partition into two distinct compartments, connected by a pipe with valve, and each having a separate lid. This enables the pure oil compartment to be always kept closed, and avoiding spattering dirty oil into the pure oil chamber.

The small compartment comprising one-third of the entire filter, is a receptacle for dirty oil and water, and contains a funnel for receiving the oil and a steam coil for heating the water. The waste oil is first emptied into the funnel (the top of which is fitted with a removable sieve) and, descending the funnel tube, is discharged below the surface of the water through holes in the foot of the tube, when it rises to the surface. The thinning of the oil by its exposure to the heat in rising through and resting on the surface of the water, causes the precipitation by gravity of all the heavy particles of grit and dirt which are flushed out at bottom of tank. Owing to a large waste oil capacity this precipitation is prolonged for some time, thereby practically purifying the oil before leaving this compartment. This cleansing is, however, only preliminary to the actual process of complete filtration obtained in the adjoining chamber.

When sufficient impure oil has been introduced to reach the level of the inlet pipe, it flows into the filter cylinder suspended



SECTION OF WHITE STAR FILTER.

in the larger compartment, which is a reservoir for the pure oil. This filter cylinder, which is covered by patents, is an extremely important part of the filtration process, and gives the White Star an advantage both in facility and efficacy of its operation. It consists of a sheet metal neck and bottom with a section of coarse wire mesh between, around which several layers of specially prepared cloth are wrapped and bound with cords. The oil in passing out of the cylinder through the cloth, is absolutely and quickly freed of every remaining impurity, and accumulates in the surrounding chamber which comprises the remaining two-thirds of the filter, and gives a large storage capacity for pure oil. The filtering surface of the cylinder is always equal to the area of the cross-section of the entire tank.

Experience with all filters demonstrates that a filtering material cannot retain its full filtering virtue unless cleaned often. This is clearly shown by the fact that the filtering cloth in the White Star, which is required to only remove the fine impurities in the oil, becomes completely clogged in time, necessitating its occasional cleaning. Of all the admirable qualities possessed by the White Star, none are more practical or more valuable than the ease and facility with which the entire mechanism can be cleaned without removing a drop of pure or waste oil, and without practically tearing the filter to pieces. To clean the filtering cloth all that is necessary is to close the valve in the pipe between the chambers, lift the cylinder out and hold it across top of filter, permitting any oil therein to run into the funnel through the hole in the neck. After the oil is drained out of the cylinder it is inverted over the funnel, the flange on the cylinder fitting exactly in the opening, thereby holding it in position while taking off or putting on the cloth. The cloth is removed by untying the cords holding it to the cylinder, taking hold of the free end with one hand, steadying it with the other, and pulling it off, which is easily

done, as the cylinder revolves freely in the flange. The cloth removed is immediately replaced by a clean one kept in the pocket in cover, the operation being in reverse manner to taking off, and as easily and quickly done. The dirty cloth removed is then washed with soap in lukewarm water, dried, and put in the pocket provided for the purpose.

Each filter is furnished with two cloths, which will last for years, thus requiring no further expense for operation. The virtue of this specially prepared filtering cloth lies in its uniform density throughout.

The Pittsburgh Gage & Supply Company, Pittsburgh, Pa., manufacturers

of the White Star oil filter, have issued a handsome booklet which is an innovation in mechanical literature, being profusely illustrated with half-tone engravings taken from life, showing the operation of filtration and process of cleaning from beginning to end. This booklet is also noteworthy, inasmuch as it does not deal in generalities but gives dimensions of every filter, its waste oil and pure oil storage capacity, as well as the normal filtering capacity.

The White Star courts comparison with other devices on each and every point that the crucial test of actual use has proven to be essential to absolute filtration.

Every manufacturer—every engineer, interested in oil filtration, whether he possesses an oil filter now or not, should have a copy of this booklet, in order to be fully posted on this most important economy. The Pittsburgh Gage & Supply Company will gladly mail a copy to all interested.

From the prominence which the Colliery Guardian, of London, has been giving, since the first of the present year, to coal mining machines, it would seem that as far as the technical press of the country is concerned, an effort is being made to introduce these machines into England, and to educate the operators and miners up to their use. A recent writer in an English periodical attributes the great increase in production in the United States during 1900 over the corresponding increase in Great Britain during the same time, to the greatly increased use of coal-mining machines in the United States, and urges the necessity for their adoption in England if the English output of coal is to increase in anything like the same proportion as our own.

Safety Lamp for Fire Bosses and Shot Firers.

We illustrate herewith Mr. A. H. Stokes' Safety Lamp with standard alcohol flame adjustment for the detection of small percentages of inflammable gas.

This lamp is a modification of the Gray type and is especially designed as a gas tester. The poles or standards are hollow tubes, so that the inlet feed can be taken from the top of the lamp, enabling a test to be made at as high a point as the top of the lamp can be placed. The glass is considerably longer than an ordinary lamp so that the length of flame can be better measured. The lamp bottom Fig. 1, is provided with a small tube *b* passing through the oil vessel, similar to a wick-picker tube, but of larger diameter. This tube is placed immediately behind the wick holder of the oil flame and terminates on a level with the top of the wick tube *a*. The bottom end of this tube terminates in a sunken circular cavity in the bottom of the oil vessel, which cavity is closed by a screw plug *c* when the tester is not in use. The upper portion of the tube inside the lamp glass is protected by a spring cap or extinguisher *g* which opens to receive the tube of the alcohol tester and closes upon its withdrawal, the opening and closing being automatic, so that no flame can pass down *b*, even should the screw plug *c* not be replaced after the test has been made.

The alcohol tester Figs. 2 and 3, consists of a small brass cylinder *e* for holding alcohol and a long wick tube *i* which screws into the top of the vessel. The wick tube is only $\frac{1}{4}$ of an inch in diameter and 2.20 inches long. The wick consists of two strands drawn from an ordinary round wick used for an oil lamp. The

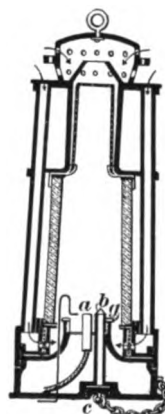


FIG. 1.

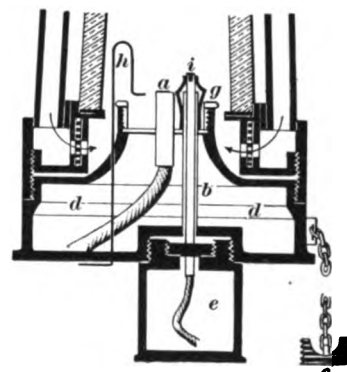


FIG. 2.

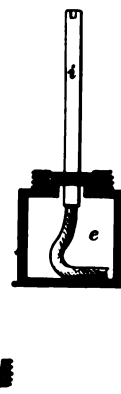


FIG. 3.

wick tube *i* when not in use is protected by a cap or covering. The tester is charged with pure alcohol before being taken into the mine and is calculated to burn for about four hours, thus permitting 120 tests of two minutes each, to be made without refilling.

The alcohol flame is not intended for use in an examination of ordinary working places, but is for use when the oil flame of a safety lamp has failed to detect gas. The official using the lamp first tests with a reduced oil flame, and if this fails to indicate the presence of gas, he raises his oil flame to its normal height, and, having placed the alcohol tester in place as shown in Fig. 2, the heat of the oil flame very soon causes the alcohol to ascend the wick tube and to become ignited, and the lamp may be tilted so that the flame from the oil more quickly ignites the alcohol. The oil wick is then withdrawn and only a pale blue alcohol flame remains, and if no cap appears the atmosphere may be considered as virtually free from inflammable gas or as containing less than .5 of one per cent. of gas. If a gas cap appears its intensity of color and length give the percentage of gas. The testing is facilitated by placing a small slip of black cardboard around the front of the glass cap of sufficient depth to cut off from view the whole of the alcohol flame and long enough to be held by the two standards. The following table shows the gas caps corresponding to the different percentages of inflammable gas.

Per Cent. of Gas.	Inches.	Gas Cap Remarks.
.5	.60	Very pale, not clearly seen.
1.0	1.00	Pale blue, clearly seen.
1.5	1.44	Pale blue, clearly defined.
2.0	1.68	Clear blue cone.
2.5	2.00	Distinctly defined gas cap.
2.0		Oil flame used.

These lamps are made by Messrs. John Davis & Sons, Derby and London, England, and 140 West Fayette St., Baltimore, Md., which firm also makes a large number of other safety lamps, anemometers, mining, surveying, engineering, and mathematical instruments.

VALUING A MINING PROPERTY.

Some of the Difficulties Met With in Examining and Estimating the Value of a Mining Property.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

Investors or those contemplating investing in a mine or prospect are often not very familiar with the difficulties in the case, when they desire the mining engineer in his report to estimate the value of a mine on "ore in sight" or ground blocked out. They may be apt to imagine that a metal mine is like a coal mine, where the seams are of nearly uniform width, size and value, and all an engineer has to do is, after taking assays of the ore exposed, to measure up with a tape-line the ground blocked out by shafts and levels and by a simple arithmetical deduction foot up the results. It would seem a comparatively easy matter, but usually it is far from this, and the results of such estimates of blocked ground and "ore in sight" at best must be considered as only approximate, and a prudent engineer will usually allow himself a large margin on the undervaluing rather than on the overvaluing side of the ledger.

It is rare that a mineral vein or ore body resembles at all a coal seam, with ore and values equally distributed from wall to wall and pretty generally so throughout the mine. On the contrary in most veins ore will vary in value and width yard by yard or even foot by foot. In one part of the quartz vein between walls there may be a "pay streak" and a few feet farther on there may be none. In another part of the vein there may be a pay streak of smelting ore and a large percentage of low-grade mill dirt, a little farther and the gangue between walls may be occupied wholly by mill dirt or concentrating ore and no pay streak at all, and so from point to point through the mine. We may note here that whilst assay samples may give a fair idea of the values of pay streak smelting ores and such usually narrow ore bodies, such a method is very uncertain in the case of large bodies of low-grade mill dirt or concentrating ores. The only fair test of these is a mill run of a large quantity.

It will be obvious that the task of footing up the values of these varying quantities and conditions, and so estimating the value of a certain block of ground presumed to contain them, is no light or certain task.

Let us consider first the width of ore bodies as they are apt to occur in mines.

In a great many mines, especially those in a granitic, gneissic or schistose region, the ore and even the vein stuff is apt to occur in "lenses," that is a body of mineral, shaped like the lens of a magnifier, or in more familiar parlance, like a pancake, thick in the middle and thinning out on all sides. A vein is apt to consist of a series of these lenses, strung together laterally and vertically, thick in the middle and thinning out to a mere feather edge both vertically and laterally. These lenses may be strung together pretty closely, so as to make an almost continuous chain or sheet, or more frequently they are disconnected and several feet apart. An ore lens may appear in a drift for a distance of several feet, continuously for even 50 or 100 feet or more, attaining a good fair thickness, and then gradually, or it may be quickly, thinning out. Then there may be a gap for quite a distance before another lens begins, widens, and similarly thins out. This may take place both laterally along a level, and vertically down through the blocked out ground to the next level.

By "blocked out" ground we mean bodies of ground presumed to carry mineral bodies and situated along the course or strike of the vein blocked out by two vertical shafts or upraises at a certain distance apart and by horizontal levels connecting the two shafts at a vertical distance of usually 50, 75 or 100 feet. This ideal condition, by no means always to be found in a mine, would show up a block of ground on four sides, it may be of a thickness of 2 to 6 or 10 feet, according to the size of the vein. It is desired, from what is shown or exposed of the ore body in the shafts on either side and on the levels above and below, to form an estimate of the probable value of said block. A comparatively easy matter if the ore bodies were of uniform size and value, or nearly so, but when, as we have shown above, the "lenticular habit" comes in as a feature, the difficulties are very great. In the top level you may measure the length and thickness and arrive at the approximate values of the connected or disconnected lenses, but on going down to the next level, 75 feet below, you may not find any lens at all or its position in relation to the next lens may have entirely changed and values likewise be different. You cannot say how far into the blocked ground these lenses may extend, what blank places there may be or what very low or very high grade pockets or bodies of ore may in this concealed zone be present.

A case in point. In a certain mine, characterized by these irregular lenses, the mine was notorious for containing occasion-

ally extraordinary rich "pockets" mingled with much and constantly varying lenses of mingled rich smelting ore pay streaks, and comparatively low-grade bodies of mill dirt. In an upper level, the vein would show narrow and not very close connecting lenses of fairly good grade ore. In the level 75 feet below, the lenses were wider and more continuous and the grade of ore better. What sort of estimate could one form of the entire block from these signs, and what if, as was highly probable, the block should contain an exceedingly rich concealed body, lens, or pocket of ore so characteristic of this particular mine in the very heart of it.

It appeared to us that in a mine of this kind, and, in fact in examining every mine, it is advisable first to go through the mine in a preliminary way, getting a general idea or impression of it as a whole, accepting for the time being such estimates of the values of ore and lenses as the superintendent or foreman may vouchsafe to give, observing any signs of true fissuring such as slickensides and gouge, appearance of intrusions of porphyry, noting their influence locally on the ore, whether enriching it locally or not, etc.; noting the general characteristics of the ore, whether it contains enriching minerals, such as grey copper, or other minerals, observing any telluric or other peculiar characteristics of the quartz, any local peculiarities which the superintendent or foreman claim to have found to be a good sign of rich ore or the contrary; any pockets whence free gold had been taken or extraordinary values or the contrary; noting whether there is a tendency of the lenses to increase in size or value or to contain more or less valuable enriching ingredients laterally or vertically, that is on one side or the other, or whether the lenses increase or decrease in these respects with depth, accepting all information given as correct for the time. Noting also a possible splitting of the veins locally or "horres" or even faults, the general trend or direction of the principal ore shoots, how wide they are and how far apart, whether or not they appear to thicken or increase in depth laterally or vertically. We may pay especial attention to the bottom level, how things are looking there, whether or not the vein or ore streak is thicker there, whether enriching ores are more abundant, whether the lenses appear wider or more continuous than in the upper levels, or the contrary; in other words, it is important naturally to see how the mine is "leaving off" according to the latest working, both vertically and laterally as offering a certain degree of probability as to the future possibilities with future development.

This trip will probably occupy the whole of the morning, if the mine be a small one. After dinner we may go over the surface, note the course of the vein outcrop, see the various prospect holes located on it; listen to the accounts given of what in early days was said to have been taken out of these surface prospects. Following the course of the vein, we may observe the mines of other companies located on it. It will be of importance, if possible, to visit these, especially any mine located at the limit of the end lines of the property in question, as the experience in these mines is likely to prove to be the experience of the mine in question with its greater lateral development on the same vein. The record of mines on adjoining properties on parallel veins is of importance also, because there is often a similarity in a family of parallel veins. We may then, after these preliminaries, go to our hotel and think over and sleep over what we have seen, and next morning begin the serious work of a minute and close examination with note book, geological hammer, tapeline, and sample bags, etc. in hand. The work now consists of a minute and careful examination of what in a preliminary way we went over the previous day. The length and width of lenses is carefully measured and estimated by rough sketches made of them and the character of the ore and the presence, absence or percentage of peculiarly enriching minerals noted, and assay samples taken in the usual way across the thickness of the vein, and at regular intervals along it according to judgment, samples in places taken separately of the pay streak of smelting ore and the mill dirt and an average sample of both together, and so from level to level. As each sample is taken, the exact locality in the mine is noted in the note book, together with any remarks. On returning to the surface, we may be able to obtain a copy of the working map of the mine, and on this locate the spots where the assays were taken and subsequently their returns, thus giving the approximate value of the ore at that point or for that lens. These records will greatly aid in forming an estimate of the average value of the mine as a whole or the "blocked out" ground. In no better or more forcible way either can an idea of the value of the mine as a whole be made to investors in the East or elsewhere. On the map these investors can in a certain sense foot up the probable values for themselves.

Having received the returns from the assays, how is the mining engineer going to give his clients an estimate of the value of such a mine as we have described? By an arithmetical averaging of the values in the blocked out ground of "ore in sight" so

called? We think not, so much as by a general impression in his own mind of the mine as a whole, taking everything in his power into consideration, he condemns or recommends it. A mining engineer of experience has generally formed his impression of the mine after his first preliminary visit, he has a sort of feeling in his bones that makes him say to himself, "The reason why I cannot tell, but I don't like you Doctor Fell," or the contrary, but he awaits the results of his assays and inquires into other factors before he gives his final opinion.

It is not, we think, always just or wise to exact of an engineer this or that in his report. If he is a man they can rely upon, his "say so" should have some weight, with his clients whether it is according to the prescribed rule the investor has in mind or not.

We have known cases where a mining engineer was required to report on a mine on "ore in sight blocked out." He examined the mine, and according to this prescription reported unfavorably. The development of the mine and other conditions did not admit of ore in sight being properly blocked out. So he had no recourse but to condemn it, but when asked his private opinion, he said he thought very well of the mine and would be willing to stake his chances on it as an excellent prospect.

You can't estimate a mine like you might a potato patch. Nature will not be shut up by conventional rules or be tied up by red tape or rule of thumb. A broad latitude for private judgment and his own ways of doing things should be accorded the mining engineer who undertakes to examine a mine, and the same latitude and margin should be allowed him in his report.

The Jeffrey Electric Power 48" Cut Shearing Machine.

The accompanying illustrations give a very clear idea of the latest designed shearing machine for coal mining, manufactured by the Jeffrey Mfg Co., of Columbus, Ohio.

Fig. 2 shows a side view of the machine mounted on truck

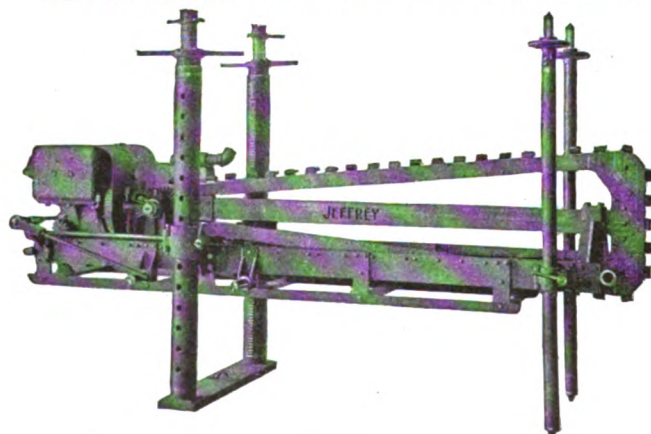


FIG. 1.

wheels. (It might be well to state at this point that it is not necessary to remove these wheels when shearing the coal.) It will be seen that there is no separate truck, but the wheels run on gudgeons or spindles, fastened to specially designed cross-ties that support the outside frame of the machine. The outside frame is constructed of heavy steel angles with the flanges turned in which give a broad wearing surface for the carriage that carries the motor and gearing.

The material used in the construction is steel, with the exception of three gears which are of phosphor bronze and the rack (malleable iron) which is bolted to the inner face of the outside frame. This rack is cast with open teeth so that any obstacle that may lodge on it is pushed through by the feed pinion

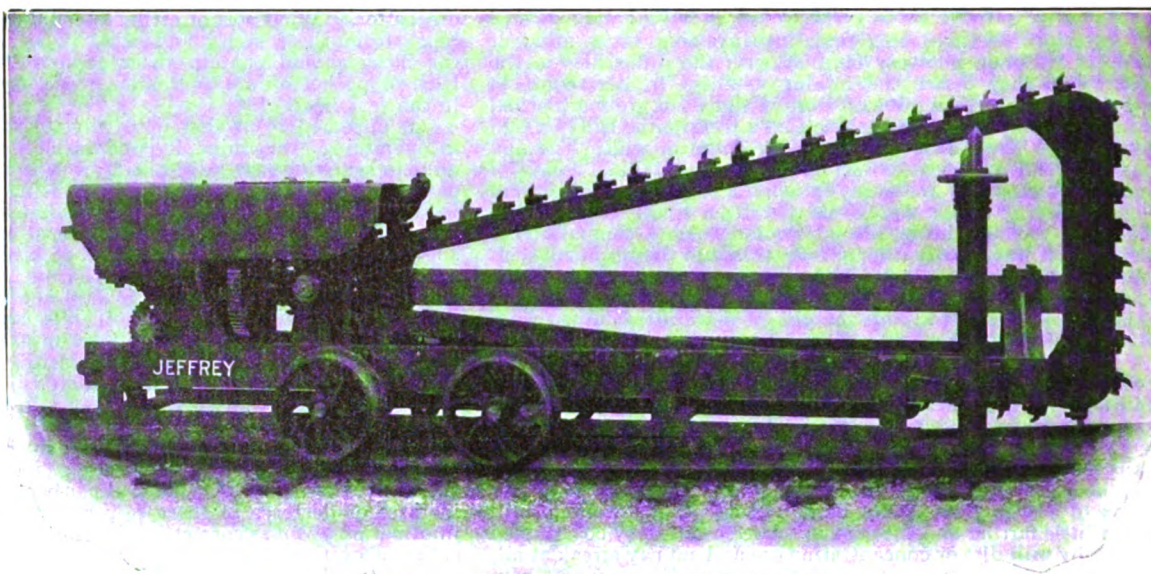


FIG. 2.

teeth, which avoids clogging and undue strain on the teeth.

Another feature is the cutting chain, which is interchangeable with cutter chains on Jeffrey standard undercutting machine, and runs over so that as the bits come in contact with the coal all the cuttings are carried down and brought out at the bottom of the kerf, where they are easily gotten at to be removed if necessary.

This machine though originally designed for entry driving can be used with equal advantage for shearing rooms in a great number of mines. The motor and gears are perfectly protected by a heavy sheet steel cover and in case of wet roof the shape of the cover is changed somewhat so that all the water that may drip is carried away from the motor.

The machine has been fitted with trolley pole so that it may be moved from one working face to another in a mine by its own power, thus avoiding delay incident to moving by mules or horses. It is built in sizes to shear to a depth of six or seven feet. Each cut being either 36" or 48" high. When a vein of coal is to be sheared, which measures more than 36" or 48" thick, columns are arranged to side of machine upon which it can be raised or lowered readily by means of a ratchet, as shown in Fig. 1.

This is only one of the styles of coal cutting machines which the Jeffrey Mfg. Co. build, their line also includes electric and compressed air breast or chain machines, built for either thick or thin vein coal, electric locomotives, electric and compressed air drills and all kinds of elevating, conveying and screening machinery for handling coal.

The following table is given by the Railway Age for the relative position of the several States in regard to population and railway mileage:

States.	Population.	Railway Mileage.	States.	Population.	Railway Mileage.
New York	1	7	Maryland	26	39
Pennsylvania	2	2	Nebraska	27	14
Illinois	3	1	West Virginia	28	32
Ohio	4	5	Connecticut	29	44
Missouri	5	9	Maine	30	34
Massachusetts	6	33	Colorado	31	16
Texas	7	3	Florida	32	20
Indiana	8	11	Washington	33	25
Michigan	9	8	Rhode Island	34	49
Iowa	10	4	Oregon	35	36
Georgia	11	13	New Hampshire	36	43
Kentucky	12	23	South Dakota	37	26
Wisconsin	13	12	Oklahoma	38	47
Tennessee	14	21	Indian Territory	39	40
North Carolina	15	19	Vermont	40	45
New Jersey	16	31	North Dakota	41	29
Virginia	17	18	District Columbia	42	50
Alabama	18	17	Utah	43	37
Minnesota	19	10	Montana	44	24
Mississippi	20	28	New Mexico	45	35
California	21	15	Delaware	46	48
Kansas	22	6	Idaho	47	41
Louisiana	23	30	Arizona	48	38
South Carolina	24	27	Wyoming	49	42
Arkansas	25	22	Nevada	50	46

NEW INVENTIONS.

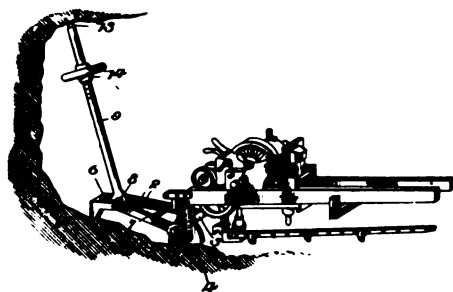
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

Single copies.....	5 cents each.
Copies by subclasses.....	3 cents each.
Copies by classes.....	2 cents each.
An entire set of patents.....	1 cent each.

REAR JACK FOR COAL-CUTTING MACHINES.

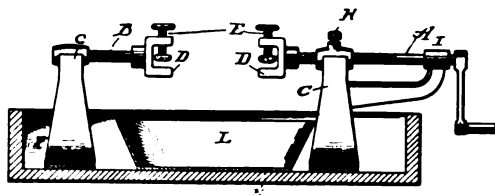
No. 667,823. D. W. JONES, RANDALL, O. *Patented Feb. 12, 1901.* The device covered by this patent is illustrated in the accompanying figure, and is intended for confining the rear end of a coal-cutting machine so as to prevent displacement or vibration. It consists of a frame or base 2 which is provided with a foot at the end 6 to engage the floor and notches at the ends 4 which engage the ends of the shaft 3 of the coal-cutting machine, thus holding it down to the floor. The base 2 is provided with a



cross brace 7 at the end near the machine and with a brace or shaft 8 near the end 6. The jack or rod 9 is provided with an open end which fits over the brace 8. The wheel nut 14 is so arranged that it can be made to force the point 13 into the wall, thus securing the base 2 against the floor and the machine in such a manner as to confine the rear end of the machine.

AMALGAM SQUEEZING MACHINE.

No. 668,488. J. V. COLEMAN, SAN FRANCISCO, CAL. *Patented Feb. 19, 1901.* The device covered by this patent is intended for squeezing the surplus mercury out of amalgam. It consists of two upright standards C, C, which are placed upon any suitable base, as, for instance, the bottom of the trough K. These standards carry shafts A and B, and one or both of the shafts is arranged to turn by means of a crank, as shown on the shaft A. At the ends of the shafts there are clamps D, carrying clamp screws E. The ends or sides of the amalgam

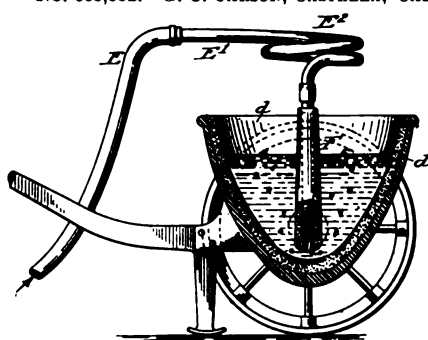


bag are clamped between the clamp screws and sides of the clamp, after which the bag is twisted by rotating the crank on the shaft A. The shaft A is threaded and passed through threaded bushing in the bearing, the outside of this bushing being loose and being prevented from rotating by pressure from the setscrew H. By adjusting the pressure of this setscrew it is possible to adjust the rate at which the shaft A will advance and so control the tension upon the amalgam bag. The strained mercury is collected in the pan L. The shaft A is provided with a second bearing I, so as to prevent the bending of the shaft while turning the crank.

DESULPHURIZING COPPER MATTE.

No. 668,952. G. C. CARSON, CASTELLA, CAL.

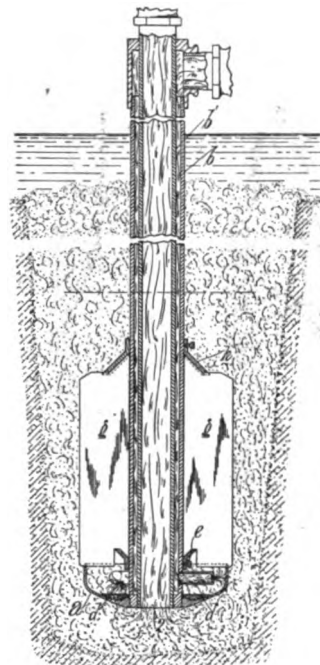
Patented Feb. 26, 1901.



The matte formed at a furnace is intended to be tapped into the pot shown, which is provided with a refractory lining d. Compressed air is forced through the flexible pipe or hose E to the pipe E'. One end of this pipe is formed into a coil shown at E'. Beyond the coil there is a straight portion covered with a refractory lining, as shown at F. By means of this device air is introduced into the matte in a pot and rapidly oxidizes the sulphur to sulphur dioxide, thus raising the metallic contents by desulphurizing the matte. The object of the coil E' is to heat the entering blast so that it will not have so great a tendency to line the metal or matte.

HYDRAULIC AMALGAMATING MACHINE FOR EXTRACTING GOLD FROM SAND IN PLACE.

No. 669,911. G. S. BARTHOLOMEW, LOS ANGELES, CAL. *Patented March 12, 1901.* The object of this invention is to provide an arrangement which may be forced down into sand and the sand agitated by currents of water and any gold contained therein recovered by being amalgamated upon suitable surfaces. The device consists of suitable tubes b, b' through which water can be forced down. The inner tube b has an opening 3 at its bottom through which water



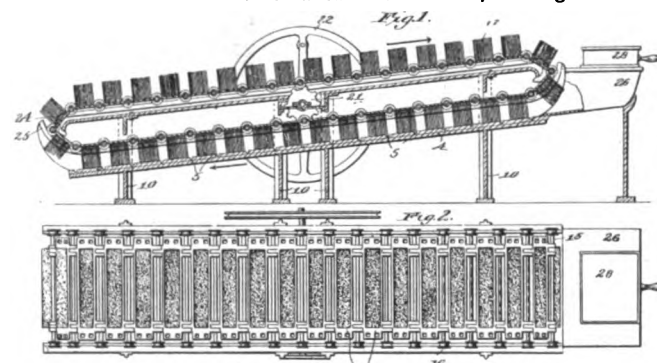
PROCESS OF ELECTROLYTIC PRODUCTION OF NICKEL OR ALLIED METALS.

No. 665,915. WM. KUGEL, BERLIN, GERMANY. *Patented Jan. 15, 1901.*

The object of this invention is to so arrange the electrolyte as to obtain thick deposits of malleable nickel, similar in nature to rolled nickel. Under ordinary circumstances only very thin deposits of nickel can be produced without scaling off. With an ordinary electrolyte, if the temperature is raised a thick deposit may be obtained, but it will be of a crystalline nature and the deposition must take place from a neutral bath. In the present invention the bath is made acid by a suitable acid, as for instance perchloric acid, perbromic acid, or sulphuric acid. No acid must be used which will be decomposed by an electric current and will not again immediately reunite in the same form. The electrolyte must also contain a salt composed of some light metal and one of the acids named above. Magnesium seems to fill the bill better than any other one of the salts. If the bath is not arranged just right it will be necessary to use very small anode surfaces in order to prevent the rapid neutralization of the acid bath. The inventor claims that where practicable the temperature should be as high as possible, i. e., from 90 to 100 degrees Centigrade, on account of the fact that this high temperature increases the conductivity of the solution without injuring the character of the deposit. He claims, however, that in cases where it is desired to deposit the metal on surfaces which will not stand this high temperature, it is perfectly feasible to make the deposit at 30 to 40 degrees Centigrade. The inventor also claims that it is possible to deposit an alloy of nickel, copper and zinc and thus form a white metal. The electrolyte in this case being made up of the salts of the metals to be deposited.

DRY WASHING MACHINE FOR GOLD.

No. 669,928. L. D. HUBBARD, CHICAGO, ILL. *Patented March 12, 1901.* This device consists of a cast-iron table 4 having transverse

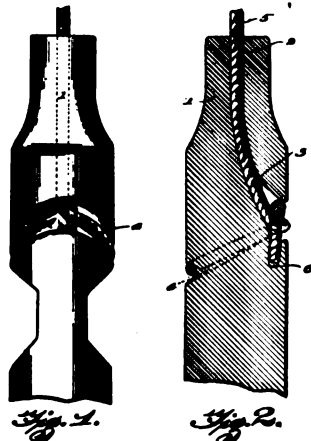


grooves 5. The table is mounted upon suitable supports 10. At the head of the table is arranged a sand box 26 and a sieve 28 for sifting the sand into the sand box. The grooves 5 are filled with mercury, and an

arrangement is made by means of which more mercury may be added at one side of the machine at the amalgam and mercury may be drawn out at the other side without stopping the machine. Supported above the table 4 are a series of brushes 17 traveling upon an endless belt as shown. These brushes are composed of frames 14 carrying wire brushes 17. The frames are hinged together and supported upon shafts 15 carrying wheels 16 which run upon tracks 24 and 25. The brushes are operated by means of a sprocket wheel 21 driven by a hand wheel 22. The sand is brushed down over the table by means of the brushes and any gold which it contains is caught by the quicksilver in the grooves 5.

ROPE SOCKET FOR WELL-DRILLING TOOLS.

No. 668,828. G. F. BELL, SISTERSVILLE, W. VA. *Patented Feb. 26, 1901.*

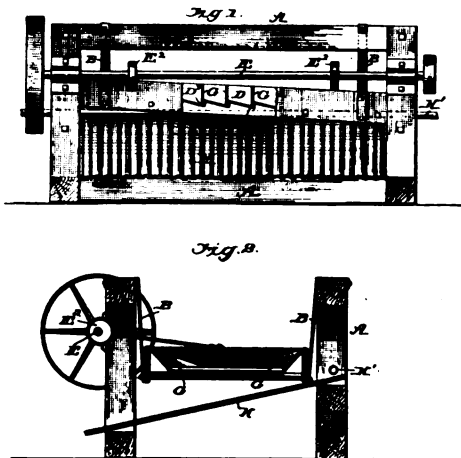


removed from the annular groove 4.

The object of this device is to provide a means for fastening a wire rope to the outer end of a set of drilling tools. 1 represents the upper end of the drilling tools, having a hole 2 drilled in the center of the top of the stem and connecting with an inclined curved opening 3. Through this opening the rope 5 passes. The opening 3 goes out through the side of the rod, as shown, and across this opening is placed the diagonally arranged annular groove 4, intended to receive the bight or loop of the cable 5, as shown in Figs. 1 and 2. The end of the rope is turned down and tucked into the socket 6, being passed under the cable 5, as shown in Fig. 1. The greater the strain on the cable the tighter will it grip the end, but the rope may be easily removed by pushing the cable down through the hole 2, thus releasing the pressure on the end and allowing the bight to be

ORE CONCENTRATOR.

No. 668,980. C. A. CHRISTENSEN, ORE TOWN, ORE. *Patented Feb. 26, 1901.* A is a suitable supporting frame for carrying the device, D represents the concentrating pan as it is hung from the frame by the bars or springs B. The pan is given a reciprocating motion at right angles to its length by means of eccentrics E¹ upon the shaft E. The pan has a series of riffles formed in its bottom, as shown in Fig. 1, and at the points of these riffles there are a series of holes D¹. At the end of the riffles there are triangular guards G intended to prevent the material being operated upon from banking up and rising over the

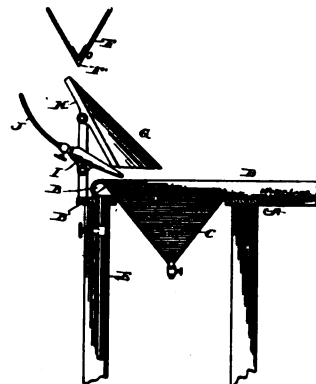


riffles next to the sides of the pan. The upper end of the pan is placed somewhat higher than the lower end and by making the supporting straps B at that end shorter than those at the tailings end. Crushed ore is fed onto the machine at one end and the tailings are discharged through the chute at the other end. The heavier material or concentrates settle to the bottom of the riffles and discharge through the perforations D¹ falling down upon an inclined plate H, down which they are washed by jets of water from the pipe H'.

ORE SEPARATOR.

No. 668,742. W. A. REDDING, MACON, GA. *Patented Feb. 26, 1901.* The object of this invention is to produce a simple and inexpensive apparatus for separating the graphite or similar materials from the gangue carrying them. A represents a supporting frame carrying the metallic box or receptacle C, the lower portion of which is drawn down into a cone as shown. This portion is provided with an overflow trough D, which is the full width of the cone C at the top. On one

side of the rim of the cone C is arranged a chamber B, which is supplied with water under pressure through the pipe E. This water escapes through a series of holes F. The flow of water through E is so adjusted that there is only a slight overflow through D and the valve in the bottom of the cone C may be adjusted so as to allow part of the water to flow out through it and carry the tailings or debris with it. The ore to be separated is crushed fine and fed from the trough F through the opening F' onto the inclined board H on the surface of which is secured a section of a cone G. This cone separates the falling material into a very thin sheet before it flows toward the water. Compressed air is supplied through a hose J to the casting I and discharged from the end of it in a series of jets. This air acts upon the thin sheet of flowing ore and graphite, and owing to the fact that the graphite is lighter than the mineral associated with it and that it is in flake form, it would be acted upon by the air and blown a greater distance, thus giving an almost perfect separation between the mineral and the graphite. The graphite floats on the surface of the water and passes off through the overflow D, while the heavy material settles through the water and is discharged through the valve at the bottom of the cone C.



PATENTS ISSUED DURING MARCH AND NOT ILLUSTRATED.

- No. 669,316. Pressure-actuated valve for rock drills, R. L. Ambrose, Tarrytown, N. Y.
- No. 669,410. Art of extracting zinc from ores, F. Guiterman, Denver, Colo.
- No. 669,411. Retort for treating ores, F. Guiterman, Denver, Colo.
- No. 669,571. Elevator and conveyer, E. C. Berghoefer, Milwaukee, Wis.
- No. 669,642. Feed mechanism for stone-sawing machines, G. D. Hunter, Bloomington, Ind.
- No. 669,671. Gravity amalgamator, J. Tobin, Brooklyn, N. Y.
- No. 669,696. Apparatus for casting metal, J. B. F. Hereshoff, Brooklyn, N. Y.
- No. 669,873. Gold-saving machine, T. Bell, Vancouver, Can.
- No. 669,909. Mine cap for draft animals, A. C. Young, Amesville, O.
- No. 669,926. Process of electrolytical extraction of metals, C. Hoepfner, Frankfurt-on-the-Main, Germany.
- No. 669,995. Hydraulic air-compressing apparatus, W. J. Linton, Woodstock, Can.
- No. 670,000. Air Compressor, F. H. Merrill, Plainfield, N. J.
- No. 670,092. Ore car, G. E. Woodbury, San Francisco, Cal.
- No. 670,116. Grinding mill, T. L. Sturtevant, Quincy, and T. J. Sturtevant, Newton Center, Mass.
- No. 670,152. Gas producer, S. Forter, Pittsburg, Pa.
- No. 670,155. Conveyer, A. D. Jansen, Johannesburg, S. A.
- No. 670,210. Excavator, W. Shannon, Cleveland, O.
- No. 670,212. Iron shaft furnace for burning cement, etc., W. H. Stein, Sablon, near Metz, Germany.
- No. 670,219. Stone-sawing machine, E. I. Bell, Portland, Conn.
- No. 670,279. Crucible shaker, John Illingsworth, Newark, N. J.
- No. 670,299. Manufacture of artificial stone, W. Schwarz, Zurich, Switzerland.
- No. 670,322. Blast-furnace charging apparatus, J. Kennedy, Pittsburg, Pa.
- No. 670,402. Mold for artificial Stone, E. E. von Hedemann and Rosenoern von Hedemann, Copenhagen, Denmark.
- No. 670,440. Electric ore concentrator, H. M. Sutton and W. L. Steele, Dallas, Tex.
- No. 670,441. Process of concentration, H. M. Sutton and W. L. Steele, Dallas, Tex.
- No. 670,549. Stamp-mill attachment, L. R. Tullock, Angels Camp, Colo.
- No. 670,597. Agitator for calcining kettles, W. T. Powers, Grand Rapids, Mich.
- No. 670,673. Hanger, for stone-sawing machines, G. D. Hunter, Bloomington, Ind.
- No. 670,750. Rock drill, W. Wood, Paterson, N. J.
- No. 670,819. Titanium compound and method of making same, H. Spence, Manchester, Eng.
- No. 670,820. Kiln for burning or calcining limestone, W. Spencer, Lothersdale, Eng.
- No. 670,639. Brake shoe, J. P. McIntyre, Chicago Lawn, Ill.
- No. 670,586. Hopper-bottom car, George A. Hancock, Springfield, Mo.
- No. 670,799. Monkey wrench, Frank X. Miller, Chicago, Ill.
- No. 670,584. Pipe and pipe coupling, Andrew Fowle Jr., New York, N. Y., Assignor to Central Foundry Co., of New Jersey.
- No. 670,681. Adjustable pipe and nut wrench, Henry J. Martin, Chicago, Ill., Assignor to Whitman & Barnes Mfg. Co., Akron, Ohio.
- No. 670,621. Water-elevating wheel, Henry H. McAdams, Boise, Idaho.
- No. 670,577. Process of removing paraffin from oil wells, George L. Ball, Alleghany, Pa.
- No. 671,345. Automatic switch, James W. Lacey, Mayline, Ala.

Mines and Minerals

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PROSPECTING FOR OIL

In Colorado—Signs Which May Indicate Oil—Geological Formations Which are Favorable.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

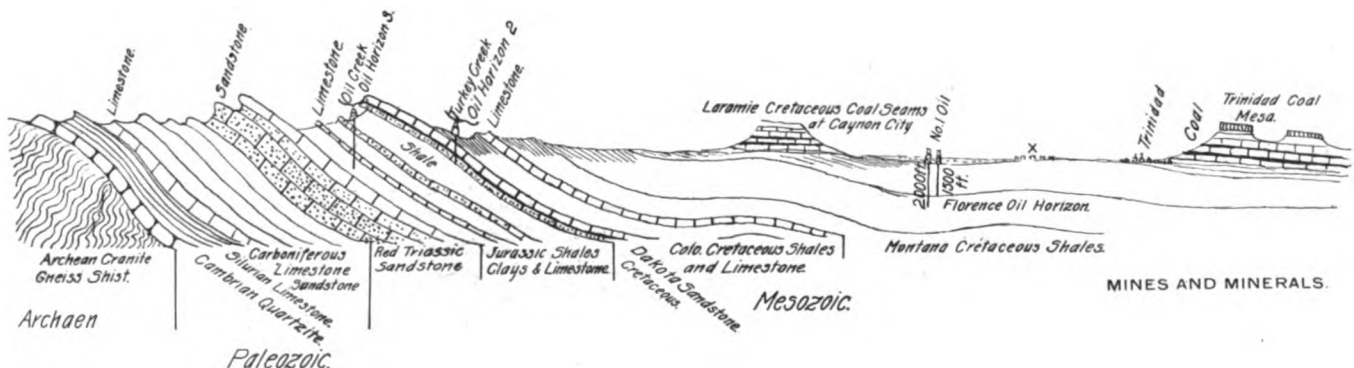
There are three and possibly four geological horizons in Colorado in which oil has been found, or oil signs have been observed. Some account of these geological zones and where they occur in Colorado, may be a guide to those who in some cases are looking for it here, there, and everywhere, and think it may be found "most anywhere if you bore deep enough."

Besides locating or mapping out the particular sets of strata or geological periods in which oil has hitherto been found, and so may be supposed to occur in undeveloped and untried fields, there are certain local conditions to be considered which are necessary,

along Fountain Creek, from Manitou to Colorado Springs and beyond, and Bear Creek from Morrison to near Denver, and several others of our largest streams. These sections show two main great geological divisions, the Paleozoic, including the Cambrian, Silurian, and Carboniferous; and the Mesozoic, including the Jura Trias and Cretaceous, with their groups and sub-divisions.

It is in the Mesozoic volume of this great earth library of periods revealed by these sections that so far we have found most traces of oil and have actually developed oil productively. Oil signs have been found in the Jurassic rocks near Cañon City in the same zone as that in which the celebrated Dinosaurs or great lizards were discovered. These strata may be recognized by their variegated red, purple, green, and maroon tints, both in shales, clays, sandstones, and limestones. This, so far, is geologically the lowest zone or "oil sand" in which oil has been detected at one or two places along the foothills.

A second zone is that of the Dakota group of the Cretaceous,



GENERALIZED SECTION OF FOOTHILLS, COLORADO.

it would seem to bring oil within available reach of the surface or to collect or store it away in subterranean reservoirs.

The public are mostly familiar with the fact that along the great granite uplift of our Rocky Mountain ranges there is a zone of foothills, representing all the strata underlying the great plains and all the geological periods forming the so-called "upper crust" of the earth, the strata being uptilted at various angles along the base of the granite range which was once the shore line upon which these various strata were laid down by seas and other bodies of water. These waves of uplifted rock of limestone, sandstone, shales, and clays, represent in parallel rotation the various earth periods and their subdivisions and subgroups from the Cambrian and Silurian at the base, resting on granite, to the Tertiary at the summit, usually found far out eastward on the plains. Cañons cut by rivers show a section of all these uptilted strata, as for instance,

forming the well-known and most prominent hogback skirting the range from north to south of Colorado. Oil signs and coagulated oil and oil saturated rock occur on the back of this highly tilted hogback at Turkey Creek, about 20 miles east of Denver in the foothill zone.

The third oil horizon and that apparently the most important, is a thousand feet or more higher than this in Montana group, including the Fort Pierre and Fox Hill shales of the great Cretaceous period, which occurs in great thickness from north to south of Colorado. It is in these marine drab-colored shales, abounding in marine fossils, that the noted oil wells of Florence, near Cañon City, have long been productively developed at a depth of from 1,000 to 2,000 feet below the surface. This Montana group of shales extends in a zone from north to south of Colorado, and is one of our thickest geological formations, often

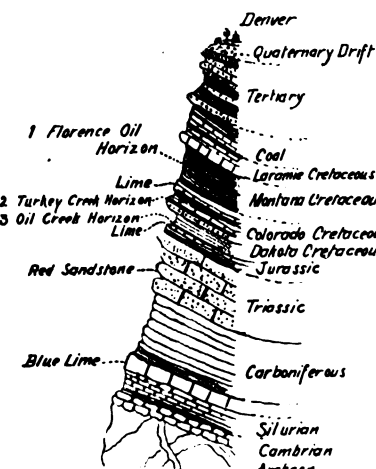
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several thousand feet thick. These shales, lie beneath Pueblo, Trinidad, Colorado Springs, Fort Collins, Greeley, Longmont, Berthoud, and many of the small towns a few miles east of the mountains. They lie between Denver and Morrison, but are there highly tilted, and it would take a well of over 3,000 feet deep to reach them beneath the City of Denver itself, as they are there overlaid by at least 2,000 feet of Laramie coal-bearing strata.

It is the same Cretaceous belt that extends up into Wyoming and makes the oil fields there, and the same belt extends into Utah and is being now prospected there for oil.

Whilst these strata, with their hypothetical oil zones, extend along the eastern flank of the mountains, the same strata are

repeated in the zone of parks or basins in the heart of the Rocky Mountain range; they occur, well developed, in South Park east of the coal outcrops at Como Station, and in Routt County near Steamboat Springs, at which latter place they are now being developed for oil with success. They are also found in Middle Park and in North Park below the lignite coal zone and over vast areas west of the Conejos and San Juan Ranges near Durango and Montrose. It may be a help to locating the zone in some places by stating that it lies immediately beneath that carrying the coal in Colorado; the drab color of the shales,



VERTICAL SECTION OF COLORADO FORMATIONS, SHOWING POSITION OF OIL HORIZONS.

the presence of gypsum and fossil shells may be another aid to recognising it.

There is no lack then in Colorado of the proper geological strata in which oil may be supposed to exist.

It is not to be supposed, however, that oil actually occurs in all this vast area of Marine Cretaceous strata. Locally, so far, it has only been found productive at Florence, and near Steamboat Springs, Routt County, but the vigorous prospecting now going on may develop it elsewhere.

Besides the right strata for oil, another condition is necessary, viz., that those strata should be in certain local conditions to hold or bring oil near the surface. Experience seems to show that these conditions are a gentle folding of the strata into low arches and shallow troughs or basins; violent uplifts with broken, faulted, and eroded summits, such as prevail in the hogbacks close to the main granite uplift, are not favorable. Oil signs may appear in such, as at Turkey Creek, but the oil has there come to the surface and expended itself, and we may in vain look for the reservoir below. A more favorable condition is to find the same oil-bearing strata forming gentle secondary rolls at some little distance from the main uplift or even under the little disturbed plains.

Geological conditions should be first carefully studied before a well is put down, otherwise the drill may be put down through strata overlying the presumed oil-bearing strata for a thickness of many thousands of feet and be in vain. Such we assume would be the case in Denver, where a thickness of at least 2,000 feet of Laramie coal-bearing strata would have to be pierced before the Montana Cretaceous oil-bearing strata could be even reached.

Before concluding we may note that gas springs are often indirect, though not invariable, signs of oil. Such springs occur quite numerous on Piceance Creek, on White River, some 20 miles northwest of Meeker, in Routt County. Here is the most powerful natural gas spring in Colorado, but borings have not as yet revealed the true presence of oil. If oil should be struck in this district it would add another and more recent geological zone to those already mentioned, viz., the Upper Tertiary. The Tertiary rocks of the Bookcliffs of that section abound in bituminous shales, asphalt, and other indirect signs of oil.

The accompanying generalized section of the foothills of Colorado will explain roughly the geological conditions and positions in which the oil-bearing strata of Colorado may be supposed to occur. The accompanying sketch map locates the position and area of the Cretaceous strata in Colorado in which oil has so far been found either in signs or productively, and in which it is most likely to be found in future by prospecting. The map is meant for prospectors. Some of the broad shaded portions mapped out may not contain oil at all or in productive quantities, but they are the best and only areas to prospect and where it is most likely to occur from geological reasons.

A few spots where wells have been located or well-defined oil signs observed are indicated by crosses X.

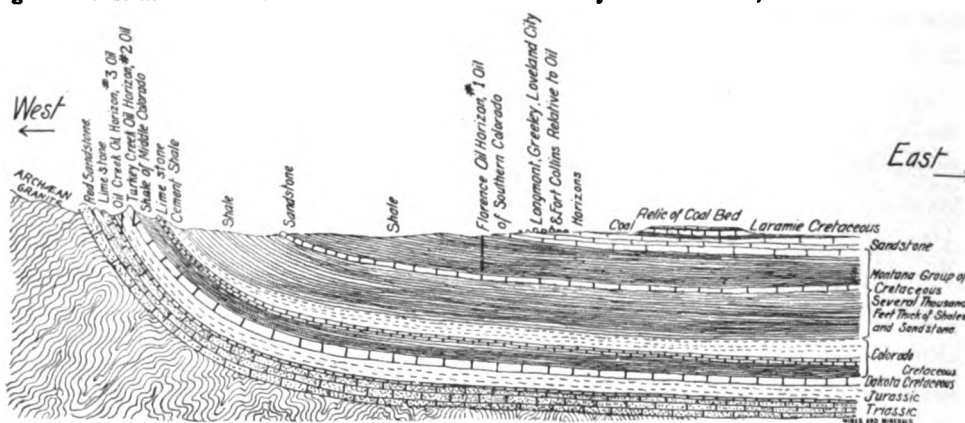
HINTS TO THOSE PROSPECTING FOR OIL IN COLORADO.

Since, so far as we at present know, the rocks of the Mesozoic age, and principally those of the Cretaceous period, mainly carry oil in Colorado, the prospector should first make sure that he is on the rocks and shales of that period, and more especially on the Montana group or subdivision of that period.

As a general rule he may recognize this group by its being usually at some distance east of, or above (geologically speaking), the great Dakota sandstone hogback so prominent all along the eastern foothills of the range. Usually the group is half a mile or more east of this hogback, occupying low arable and agricultural lands by reason of the soft and fertile character of the drab-colored shales which compose it. The group is composed of drab-colored shales, often containing concretions of lime, which, when broken, sometimes contain fossil shells; fossil sea shells are generally characteristic of this group. Then seams of gypsum also occur in the shales and occasional bands of yellow sandstone. He may observe sections of these shales along the banks of a stream, dry gulch, or arroya.

Having decided that he is on the Cretaceous rocks, he should observe whether or not the shales are highly tilted. If so, he had better go farther east till the shales begin to turn or become more horizontal or basin up. By observing the dip in sections exposed he may note whether the strata are thrown into gentle arches and shallow troughs. The summits of the arches are the best places to sink a well and next to them the bottom of the corresponding trough or synclinal. Dome-shaped masses caused by undulations along the axis of an arch or anticlinal are particularly favorable where the strata dip off every way from a given center. Failing to find any of these arches, troughs, basins, or domes, he had better locate on the flat prairie.

The next thing is to seek for oil signs; these may or may not appear. He may find sandstone or other rock soaked with oil or tarry matter which will burn readily. He should examine all springs or other bodies of water for oil scum floating on it. Oil scum is a thin film of oil which shows iridescent colors like those of the rainbow. A film very like oil scum, with the same tints,



SECTION OF FOOTHILLS NORTHEASTERN COLORADO SHOWING POSITION OF OIL HORIZONS. REPRESENTS VERTICAL THICKNESS OF ABOUT 10,000 FEET.

is often observed in marshy places, but this is not oil, but iron. It is readily distinguished from true oil scum by breaking up like a solid when stirred with a stick, and not reforming again. Oil scum, on the other hand, when stirred breaks up as a liquid and reforms again and shows its colors.

Gas springs issuing from pools are often indirect evidences of oil beneath; especially if they ignite with a reddish flame, the gas is natural gas or carbureted hydrogen. Sulphureted hydrogen gas is a less likely sign and burns bluish and emits a sulphurous odor. Carbonic acid gas does not ignite at all; it only bubbles and effervesces.

Springs of all kinds are sometimes indications; especially hot springs, saline springs, mineral springs and those that deposit

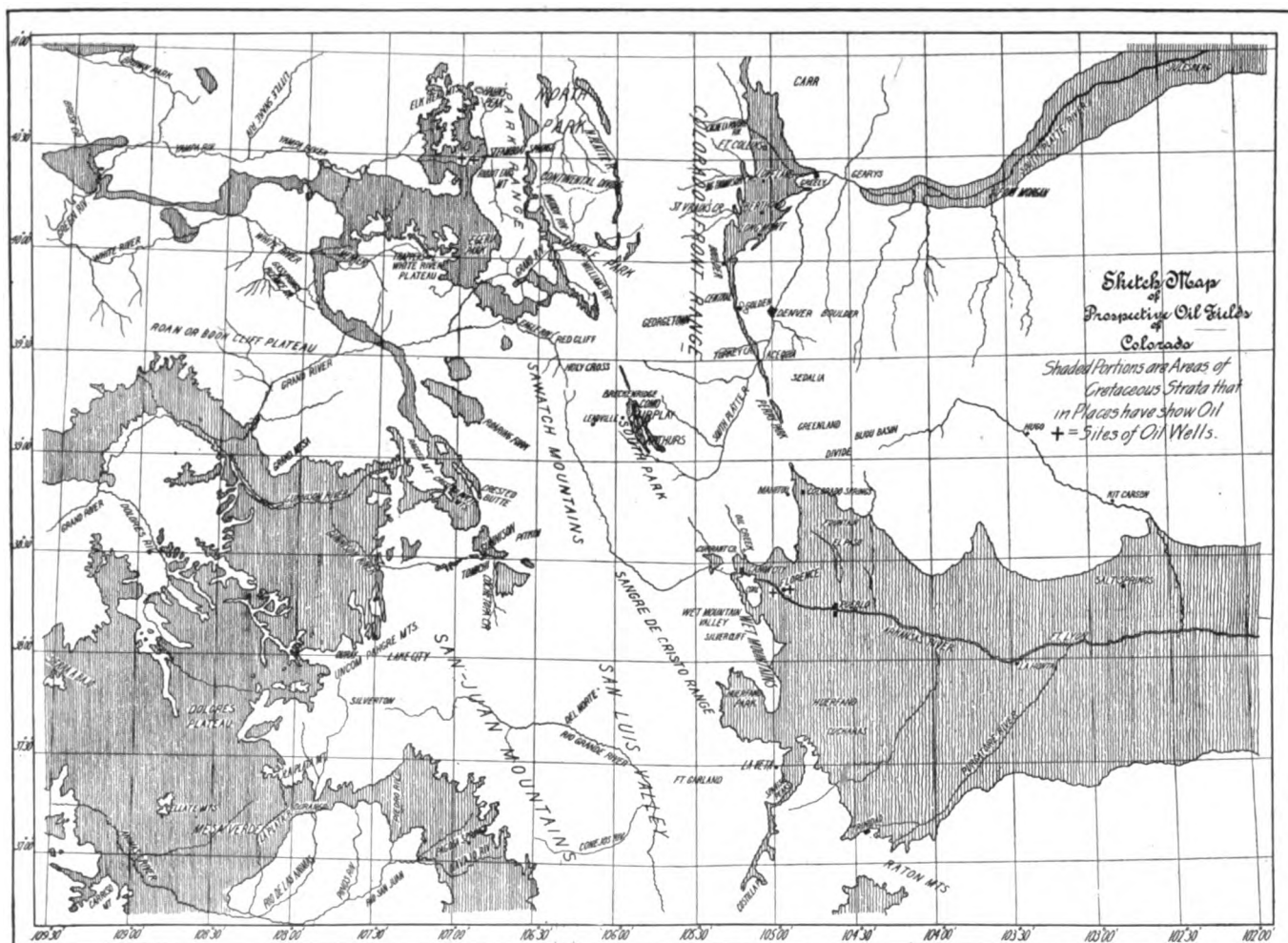
gypsum. It is well to taste or analyze these waters for traces of oil. In some regions, like California, reddish and bleached-white shales indicate oil or asphaltum beneath, but such we have not observed as yet in Colorado. The smell of a rock charged with bitumen is a way to diagnose the presence of oil. Highly bituminous shales which will light with a match, like those on Piceance Creek, Blanco County, are indirect evidences of oil in the region, as also are fissures filled with asphaltum. Porous rocks and conglomerates charged with bitumen are indirect evidences of oil.

In California subsidences of ground, leaving shallow hollows sometimes filled by a pond and usually surrounded by reddish, burnt, or white shales are indications of oil or asphaltum beneath, the subsidence being caused by the burning of shales by chemical heat, connected with asphaltine deposits. Such indications we have not as yet seen in Colorado. Whilst such oil signs are to be carefully looked for, there may be many areas in Colorado where oil exists at depth without showing any surface signs. Such localities may reasonably be prospected if they show the favorable geological conditions and structure we have described. There is con-

of the East occurs in Paleozoic strata; in the West in Mesozoic or Cenozoic rocks of far more recent date, and he may expect to find both rocks, signs and other conditions entirely different from what he has been used to, and find some difficulty in adjusting himself and his ideas to the changed environment.

The Metric System in Europe.

Some months ago (says the *Mechanical World*, of Manchester, Eng.), the British government addressed a letter to its representatives in Europe asking for information relating to the metric system in the various countries. It appears from the replies which have just been published that the change to the metric system in Austria was made in 1876, and met with many difficulties, as the new scale bore no resemblance to that which it superseded. The alteration was facilitated, however, by wise concessions, the transition period was over in four years, and the method now gives complete satisfaction in Austria and Hungary. The metric system is firmly established in Belgium, where it came into



PROSPECTIVE OIL FIELDS IN COLORADO.

siderable risk as well as much exciting and speculative interest in boring for and prospecting for oil. We will not now enter on the subject of drilling, but it has often been proven, especially at Florence, that a drill put down at one spot without success may in a few yards from it, prove up almost a gusher. Whilst we have endeavored to give some general hints and directions for prospecting for oil, we would say that wells as a rule, should not be put down or property bought or taken up until the ground has been carefully examined by a competent geologist. The same rule holds good in oil mining as in mining the precious metals. No mine or mining property is nowadays bought by prudent investors without having it examined first by a competent mining engineer.

In this respect a word of caution is necessary: A skilled practical and experienced oil man from the old fields of the Eastern States is not always a judge of the different conditions to be found in the West. He will probably be influenced in his observations by the result of his Eastern experience, but things and conditions are materially different in the West. In the first place, the oil

general use in 1855, and the question of introducing it in Denmark is under consideration, the majority of the commercial and professional classes being in favor of the reform. In France, where the law was brought into force in 1837, all authorities are agreed that the metric system has been commercially beneficial, and the principle has also been firmly established in Germany, where it was brought forward in 1868, and has been of advantage to the trade of the country. Too much prejudice against the system exists in Greece, and the government has therefore refrained from making it compulsory; but in Italy its use was made uniform by legislation in 1890. The obstacles encountered in enforcing the principle in the Netherlands have gradually been removed, and it is now in operation throughout the country. In Portugal, where the method was introduced in 1852, little opposition was manifested, as about twelve years were occupied in carrying it into effect. Spain adopted the system in 1869, Norway and Sweden in 1879, and Switzerland in 1877. Taken altogether, the metric system appears to have proved beneficial, in these countries.

METHOD OF CONNECTING SURVEY

In a Shaft Mine With That of Property Lines and Topographical Features on the Surface.

Written for MINES AND MINERALS, by H. L. Auchmuty, C. E.

In mining coal, and likewise many other minerals, it often becomes necessary to sink vertical openings or shafts to reach the veins or deposits.

The need of constructing shafts arises when it is desired to open a mine far from the outcropping of the strata which enclose the deposit.

By far the greater bulk of an extensive mineral deposit, as of coal for instance, must be obtained by shafting, as there can be but a limited number of openings made along the cropping of a vein or bed.

The ownership of the properties may occasion this necessity, or perhaps economic reasons as to haulage, or the desire to increase the output of the mine property. Long haulage underground retards the tons per day which it may be desired to mine, while a well-located shaft will greatly increase it by minimizing the haul.

When it becomes necessary to sink shafts to obtain the mineral treasures of the earth it is quite important, among other requirements, to know the exact position of the underground workings with respect to the surface features, and the lines of the property under which the mining operations are to be conducted.

This knowledge is needful for many reasons, and in particular so that the operator may remove all of the material which is being mined, consistent with the proper or necessary supports which it may be deemed prudent to leave, to protect the entries and other openings through which ingress and egress to the workings are obtained, and through which the material mined is to be transported; and also to avoid such surface features as might prove detrimental to the mining interests, such as large streams, etc.

Unless some good and sufficient means is employed to exactly indicate upon a map, or otherwise, the precise position of the subterranean workings with respect to the surface lines and topography, very erroneous conclusions may be reached as to the best method of mining certain sections of the tract, or else a large waste of the mineral to be mined may result from leaving unmined portions which might be removed if those in charge of the plant knew to a certainty just how the workings actually existed in regard to each other, and to the different surface features.

To meet these requirements a mine survey is made and the map drawn from the records of such a survey shows the precise ramifications of the mine workings, and likewise from another survey the delineation of the boundaries of the properties and such other matters of interest connected with the mining operations, as for instance the public roads, streams, buildings, etc. which may be upon the surface.

This map, as regards the underground workings is extended from time to time as additional surveys are made to show the progress of the mine's development.

One of the essential features of such a map and survey is to know beyond any possibility of doubt, that the meridian or "North and South line" from which the mine or underground survey is made, is coincident with that used in making the surface or property line survey.

When a mine is opened by means of drifts or horizontal openings, or by slopes or inclines of a moderate degree of steepness, a direct connection with the surface survey can be made by simply running the outside survey lines directly into the mine.

When the body, or central portion of the mine is reached entirely by shafts, which very likely will be several hundred feet in depth, or possibly much deeper than this, the work of connect-

ing the inside, and outside or surface surveys, is a matter requiring much more care and skill and is not quite so easily accomplished.

It is with the business of properly connecting the two surveys in such a case as this, and at the same time knowing definitely that both surveys are made upon the same meridian that this article has to deal.

Quite a variety of methods have been employed at different times to effect a solution of this problem, and often with very varying success, as resurveys of old mine workings will at times attest, when after some years of working an opening is made by which the cropping of the vein is reached or an opportunity is presented to make a check survey through the medium of a bore-hole or other opening and it is found that the survey of the workings has been made upon a somewhat different base from that of the surface lines. It is also quite important to have surveys of this character quite in agreement with each other as it is often a matter affecting the economical working of the mine.

Generally in all mining operations in districts controlled by State legislation, the requirement is made that at least two openings must be constructed and maintained from the surface to the body of the mine for ingress and egress, as well as for the purpose of hoisting, ventilating, and draining, and it is through these openings that we must carry our survey. The laws generally require that these two openings shall be not less than 150 feet apart, and often from some surface feature it may be desirable to place them still farther apart, and for purposes of an accurate survey a greater distance is preferable since it gives a larger base,

and hence a greater opportunity for accuracy in making a survey. Of course other economic conditions than that of a survey control the placing of the shafts of a mine, and in running a survey we must accept this part as we find it.

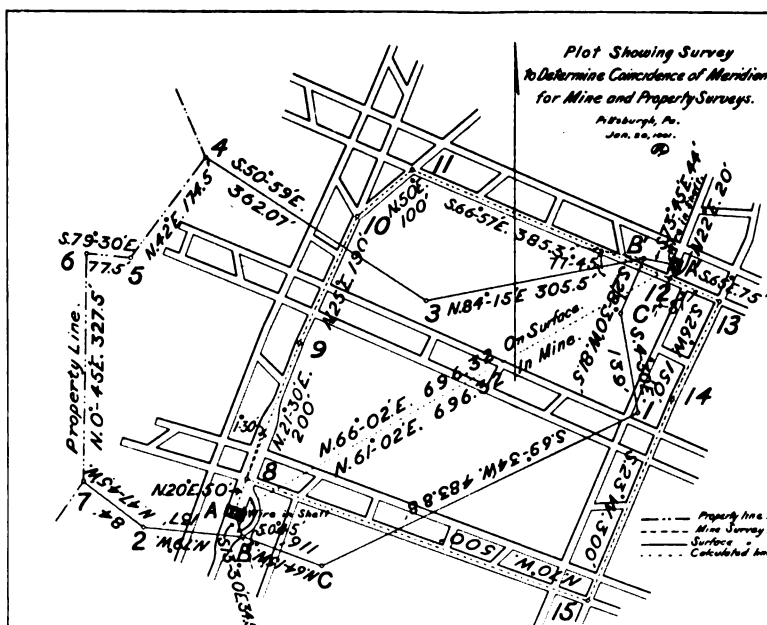
When a shaft mine is opened we have but the one excavation from which to start the workings and similarly the survey. The usual method then is to hang two wires in the one shaft, and placing a transit instrument in line with them, on the surface ascertain the direction or course of the line as given by the wires. The same operation is pursued in the bottom of the shaft; the transit likely being brought to position between the two wires, or if some excavating of the entries has been done, in line with them, the same as was done on the surface. The line thus determined and produced

is practically coincident with that on the surface. The mine is then started upon a prearranged plan, and the entries driven which will connect with the second or airshaft opening.

It is after such a development has been made, and the mine is about ready to branch out and begin operations that it becomes necessary to have a more definite knowledge as to how the inside and outside surveys agree with each other as regards the coincidence of meridians.

In making a survey connecting the inside or mine survey, with the lines run upon the surface, and when we have the two shafts to use in making this connection, the following method will be found to give excellent results.

In the first place we drop a single wire down each shaft; suspending it from a nail or beam placed at a sufficient height above the surface of the ground so that when a transit instrument is placed at some convenient point near the top of either shaft opening the wire is plainly visible, and equally accessible for measurement from instrument to wire. A light wire of copper or mild steel, the gauge depending upon the depth of the shaft is used. For a moderately deep shaft, say about three hundred feet, No. 24 gauge, or .02 inch in diameter is quite satisfactory. Various kind of weights have been tried for the purpose of keeping this wire taut in the shaft, but about as satisfactory as anything is a large turned iron or steel plumb-bob, of sufficient weight to keep the wire perfectly taut. This bob for a moderate depth would be about 6 inches in length, by about 3 inches in diameter at the large part, with a short head say $\frac{1}{2}$ inch diameter drilled to receive the wire. A



vertical hole being drilled in the center of the head, and terminating in a horizontal hole drilled from the side of the head.

One great annoyance in using these bobs is their continual turning, for hours after being hung, until the twist or torsion has left the wire. A bucket containing a heavy oil is often used, in which to immerse and steady the bob, but even then it will continue to turn for a long time. A simple arrangement consisting of a tin, cone-shaped ring, with 3 or 4 vertical wings soldered to it, and slipped over the lower part of the bob, and tightly wedged to it will, when the bob is immersed in a bucket of water, stop all vibration and torsion in a few minutes.

One of these bobs should be placed in each shaft, being suspended as previously mentioned. Although these large plumb-bobs are not an essential feature in all cases, they are quite convenient to work with, but when a survey is to be made such as will be here outlined, i. e., when there is no point, or transit position, to be permanently worked at the exact spot occupied by the wire in the shaft, any well-formed or symmetrical weight will do equally as well as the heavy bobs to keep the wire taut. These wires are simply used as a position to sight and measure to, from the assumed transit positions, and not to mark a station of the survey except as a temporary point projected from the surface of the ground to the mine excavations, of which it is desired to make a survey.

The next operation in a survey will be to drive two stakes in the ground near each shaft with a tack in each; the one being about twenty or thirty feet from the shaft opening, and the other at some convenient point some distance away, so that when the instrument is placed upon the stake near the shaft, both the wire and the other stake can be seen from the position assumed.

In the roof of the entry, at the bottom of the shaft, drive two iron points, or spuds as they are sometimes called, in such position that when the transit is set up under the one that both the wire and the other point are each plainly visible.

We are now ready to plumb the shafts, and in order to facilitate the work it is often convenient to use two instruments; one instrument being kept on the surface while the other is used in the shaft bottom.

Calling the wire in either shaft *A*; the stake on the surface, or the point in the mine, near the shaft, *B*; and the more remote stake or point *C*, we set the transit at *B* on the surface and turn the angle *ABC*, repeating the angle a number of times to insure accurate results, and to guard against error. The distance *BA* must also be measured very carefully, as we have no further check upon this part of the work. The same *modus operandi* must be gone through with in the shaft bottom, after which the two instruments are moved to the second shaft where a similar procedure is conducted both at top and bottom. The wires can now be removed from the shafts. The distance between *B* and *C* in each place must also be carefully measured and a line on the surface is run between the points *C* at each shaft. If these lines *BC* are carefully marked they can be maintained for use as a base line for a long time. These same lines must also be carefully connected with the property lines, and likewise those in the mine to the mine survey.

Besides this, when it is practicable, and the shafts are some distance apart, as we would find in the event of rerunning the survey of an old mine in which there would probably be an additional air shaft which could be used for plumbing instead of the one near the hoisting shaft, it is well to run two independent lines from *C* to *C* both inside and outside of the mine.

In order to more clearly illustrate the method we will assume a case, giving the lines supposed to be run, and the necessary calculations for determining the coincidence of meridians. We have taken a case in which the second or air shaft is at some distance from the main or hoisting shaft, thereby furnishing a better example.

We will also assume that the mine has been surveyed upon some certain meridian, as well as has been the property, with the assumption that they are probably the same. We will apply our results from plumbing the shafts to the existing meridians, and show the change necessary in the case to place the mine and property surveys upon the same meridian. Of course, in this case the difference of meridians is greatly exaggerated. For convenience sake the different points or stations in the survey are indicated by letters and figures instead of by the station numbers as is usual in a survey. (See sketch.)

First with the transit placed at *B* (in the figure) on the surface, we measure the deflection angle which *BC* makes with *AB* produced = $50^{\circ} 45'$ and also the distance from *B* to wire *A* = 34.5 ft. At the same time the deflection angle which *S-9* makes with *A-8* produced = $1^{\circ} 30'$ is measured in the shaft bottom, and distance *S-A* = 50 ft. is also noted.

Proceeding now to the other shaft, and with the instrument at *B'* on the surface the angle which *B'-C'* makes with *A'-B'* produced = $77^{\circ} 45'$, and the distance 44 ft. = *B'-A'* are meas-

ured. Also in the mine, with the transit at Sta. 12, the angle which *12-13* makes with *A'-12* produced = $87^{\circ} 00'$, and the distance *12-A* = 20 feet are measured.

On the surface we now run the line *C-1-C'* connecting the points *C* and *C'*, and also connect our survey with the property line *4-5-6-7* by means of line *B-2-7* from Sta. *B*, and line *B'-3-4* from Sta. *B'*.

In the mine we will also run the line *8-15-14-13-12* connecting the work previously done at each shaft, and for an additional check between the points *S* and *12* a survey following the lines *S-9-10-11-12* will give the necessary data. We now have two complete circuits surveyed. That on the surface taking in the lines *B-2-7-6-5-4-3-B'-C'-1-C-B* and likewise the points *B* and *B'*; while that in the mine *S-9-10-11-12-13-14-15-S* includes the points *S* and *12*, and from these four points *B*, *B'*, *S*, and *12*, angles have been turned and distances measured to the wires *A* and *A'*. From these circuits we have two lines inside of the mine, and two lines outside of the mine connecting the wires *A* and *A'*, and one of the outside lines connects to, or rather forms part of the boundary or property line of the mine tract. By means of these data we can now figure a set of two courses and distances for the line *A A'* inside of the mine, and another set of two bearings from the outside lines. Previously to doing this, however, it is necessary to calculate the value or closure of the outside and inside circuits as above mentioned, i. e., showing by means of the proper tabulation the amount of error as regards the latitude and departure of the bearings. The closure of these circuits should be well within a foot for distance, and a minute of angle.

The bearing and distance of the line *A A'* which we wish to find from this data forms a dividing line of each of these circuits.

The following table, marked No. 1, shows the calculations involved for the inside circuit.

Table No. 2 shows the same data for the outside or surface circuit.

TABLE NO. 1.

CIRCUIT IN MINE CONNECTING SHAFTS.

Sta. to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
8 to 9	N $21^{\circ} 80'$ E	200	186.10		73.30	
9 to 10	N 25° E	190	172.20		80.30	
10 to 11	N 50° E	100	64.28		76.60	
11 to 12	S $66^{\circ} 57'$ E	385.30		150.86	354.59	
12 to 13	S 65° E	75.00		31.70	67.97	
13 to 14	S 26° W	150.		134.82		65.76
14 to 15	S 23° W	300		276.20		117.20
15 to 8	N 70° W	500	171.00			469.80
			593.58	593.58	652.76	652.76

TABLE NO. 2.

CIRCUIT OUTSIDE CONNECTING SHAFTS AND PROPERTY LINES.

Sta. to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
B to 2	N 79° W	137	26.14			134.47
2 to 7	N $47^{\circ} 45'$ W	84	56.84			62.18
7 to 6	N $0^{\circ} 45'$ E	327.5	327.50		4.80	
6 to 5	S $79^{\circ} 30'$ E	77.5		14.12	76.20	
5 to 4	N $42^{\circ} 00'$ E	174.5	129.64		116.81	
4 to 3	S $50^{\circ} 59'$ E	362.07		227.94	281.35	
3 to B'	N $84^{\circ} 15'$ E	805.5	30.65		303.97	
B' to C'	S $28^{\circ} 30'$ W	81.5		71.62		38.89
C' to 1	S $4^{\circ} 30'$ E	139.0		138.57	10.91	
1 to C	S $69^{\circ} 34'$ W	483.88		168.93		453.50
C to B	N $64^{\circ} 15'$ W	116	50.41			104.50
			621.18	621.18	793.54	793.54

From these circuits, which include all the lines except the bearings and distances from the transit positions, or points, to the wires in the shafts (in each case), we see that each circuit closes exactly, and in actual work the results should not be greater than about one to two-tenths of a foot in error.

The next step will be to take the inside lines and from them to figure a bearing and distance *A* to *A'*; and Table No. 3 shows the results of the tabulation from the lines on the west side to be for this line *A A'* N $61^{\circ} 02'$ E 696.32 feet.

TABLE NO. 3.

CALCULATION OF BEARING BETWEEN WIRES A AND A' INSIDE OF MINE, FROM DATA GIVEN BY WESTERN PORTION OF CIRCUIT IN TABLE NO. 1.

Sta. to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
A to 8	N 20° E	50	44.98		17.10	
8 to 9	N 21° 30' E	200	186.10		78.30	
9 to 10	N 25° E	190	172.20		80.30	
10 to 11	N 50° E	100	64.28		76.60	
11 to 12	S 66° 57' E	885.3		150.86	354.59	
12 to A'	N 22° E	20	18.51		7.49	
			488.10	150.86	609.38	0.00
(Calculated) A to A'	N 61° 02' E	696.32	337.24		609.38	

$$\tan = \frac{609.38}{337.24} = 1.80675 = 61^\circ 02'.$$

$$\text{Dist} = \sec 61^\circ 02' \times 337.24 = 696.32.$$

Table No. 4 shows the results of tabulation of lines on east side of line A A' to be S 61° 02' W 696.32.

TABLE NO. 4.

CALCULATION OF BEARING BETWEEN WIRES A' AND A INSIDE OF MINE FROM DATA GIVEN BY EASTERN PORTION OF CIRCUIT IN TABLE NO. 1.

Sta to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
A' to 12	S 22° W	20		18.54		7.49
12 to 13	S 66° E	78		31.70	67.97	
13 to 14	S 26° W	150		134.82		65.76
14 to 15	S 28° W	300		276.20		117.20
15 to 8	N 70° W	500	171.00		469.80	
8 to A	S 20° W	50		46.98		17.10
			171.00	508.24	67.97	677.35
				171.00		67.97
Calculated A' to A	S 61° 02' W	696.32		337.24		609.38

$$\tan = \frac{609.38}{337.24} = 1.80675 = 61^\circ 02'.$$

$$\text{Dist} = \sec 61^\circ 02' \times 337.24 = 696.32.$$

Tabulations No. 3 and No. 4 thus show us that from the two sets of lines we get the same results, and even in actual work the results should either agree or show but a small error in their agreement, and especially so as regards the course, this being the

TABLE NO. 5.

CALCULATION OF BEARING BETWEEN WIRES A AND A' ON SURFACE FROM DATA GIVEN BY WESTERN PORTION OF CIRCUIT IN TABLE NO. 2.

Sta. to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
A to B	S 13° 30' E	34.5		33.55	8.06	
B to 2	N 79° W	137.0	26.14			134.47
2 to 7	N 47° 45' W	84.0	56.84			62.18
7 to 6	N 0° 45' E	327.5	327.50		4.30	
6 to 5	S 79° 30' E	77.5		14.12	76.20	
5 to 4	N 42° 00' E	174.5	129.61		116.81	
4 to 3	S 50° 59' E	362.07		227.94	281.35	
3 to B'	N 84° 15' W	305.5	30.65		303.97	
B' to A'	S 73° 45' E	44.0		12.81	42.24	
			570.77	287.92	832.93	196.65
				287.92		196.65
Calculated. A A'	N 66° 02' E	696.32	282.85		636.28	

$$\tan = \frac{636.28}{282.85} = 2.24953 = 66^\circ 02'.$$

$$\text{Dist} = \sec 66^\circ 02' \times 282.85 = 696.32.$$

important part of the work. The calculation of the distance, however, acts as a check upon the results.

We now have definitely settled that from the meridian used

in the mine work, the course for this imaginary or calculated line between A and A' (the wires in the two shafts) is N 61° 02' E.

Considering next the outside or surface survey; from these data we will establish a course or bearing for this same line. From the data as given in table No. 5, which is a tabulation of the survey lines on the west side of line A A', we find the course and distance between the two points to be N 66° 02' E 696.32 feet, while from Table No. 6 showing data from lines on east side of A A' we also get S 66° 02' W 696.32 feet. The results of the calculations from the two sets of lines being identical for both course and distance.

TABLE NO. 6.

CALCULATION OF BEARING BETWEEN WIRES A AND A' ON SURFACE FROM DATA GIVEN BY EASTERN PORTION OF CIRCUIT IN TABLE NO. 2.

Sta. to Sta.	Course.	Distance.	Latitude.		Departure.	
			North.	South.	East.	West.
A' to B'	N 78° 45' W	44	12.81			42.24
B' to C'	S 26° 30' W	81.5		71.62		58.89
C' to 1	S 4° 30' E	189.0		138.57	10.91	
1 to C	S 69° 34' W	43.88		168.93		458.50
C to B	N 64° 15' W	116.00	50.41			104.50
B to A	N 18° 30' W	34.5	33.55			8.06
			96.27	379.12	10.91	647.19
				96.27		10.91
Calculated. A' to A	S 66° 02' W	696.32		282.85		636.28

$$\tan = \frac{636.28}{282.85} = 2.24953 = 66^\circ 02'.$$

$$\text{Dist} = \sec 66^\circ 02' \times 282.85 = 696.32.$$

In comparing the bearings from the inside survey calculations N 61° 02' E 696.32 with that from the outside survey calculations N 66° 02' E 696.32 feet we find that it is necessary to turn the outside lines 5° 00' left to agree with the mine workings or vice versa, turn the inside survey 5° 00' right to agree with the outside survey. By making this change in the bearings of the surface lines we shall find that the outside and inside surveys will be upon the same base or meridian.

This changes the bearings of the three property lines 7-6-5-4 as follows, instead of as shown on the plot.

Line 7-6 N 0° 45' E becomes N 4° 15' W

Line 6-5 S 79° 30' E becomes S 84° 30' E

Line 5-4 N 42° 00' E becomes N 37° 00' E

and the mine workings and the surface lines are now on the same meridian.

World's Iron-Ore Production.

In a comparative survey of the world's iron-ore situation, the remarkable fact is brought out that the United States in 1899 produced 30% of the world's ore, or 25,000,000 tons out of a total of 85,000,000 tons, in round numbers. This quantity is somewhat less than the combined ore output of both Great Britain and Germany including Luxemburg, which produced respectively 17% and 21% of the world's ore supply. This alone gives the United States the leadership among the world's great ore producers; but this fact must be taken in connection with coal production on which the iron industry depends and of which this country produces 32% of the world's output, while Great Britain produces 30% and Germany 19%. With primacy in coal and iron ore the position of the United States is one of undisputed and permanent ascendancy in her control of the raw materials of iron and steel production. This primacy in raw materials gives the United States a self-sufficing position, as compared with that of her foremost rivals—Germany and Great Britain. While the Dortmund, Germany, furnaces have to go to Northern Sweden for iron ores and the furnaces of Cleveland (England) have to get their ores from Northern and Southern Spain, the United States are far freer to locate their iron and steel industries with direct regard to the conditions of maximum economy in the accumulation of raw materials and the distribution of the finished products. Therefore, as coke has displaced coal, the tendency the world over is for the furnace to leave the colliery and move toward the ore mines. Hence the iron and steel industries of this country are gradually being drawn around the southern shores of Lake Erie within easy access of the vast ore deposits of the Lake Superior mines. The preponderance of this single source of ore production is apparent from the fact that the Lake Superior region furnished 73% of the 25,000,000 tons of ore consumed by our furnaces in 1899, while the Southern States furnished 19% and the Eastern States but 8%. One of the most wonderful developments in modern trade is that of the ore-handling facilities from the Lake Superior mines to the furnaces of Ohio and Pennsylvania.

MINE DISCIPLINE.

What Constitutes Discipline—The Importance of System as an Aid to its Enforcement.

By D. C. Thomas, Superintendent of the Courtright Coal Co., Gloucester, O.*

The second letter of our secretary asking for papers to be read at this meeting brought from me the promise to prepare one, but judging from the program I received later he had overdone things or his letter had had the same effect on others as myself.

Mine discipline is one of the spokes in the wheel of success in mining. It matters not how well a mine manager may be posted on geology; how much he can tell you about the formation of the coal beds, and the measures they are found in, and what are false coal measures and on what do the varieties of coal depend. He may also tell you all about shaft or slope sinking, the advantage of a rectangular or circular shaft, the different methods of sinking through quicksand or water, either by the Goubert freezing process or the Trigers method with tubes, or the Kind-Chaudron system of drilling.

He may tell all about pumping and hydromechanics. He may tell you all about engines; also what the expansion curve of steam on an indicator card represents; also calculate the strength of any ropes used for hauling or hoisting. He can give you pointers on steam boilers, tell you what the mechanical equivalent of heat is, can tell you in what way you would make a positive test to determine whether the boiler feedwater contained sulphuric acid. If the plant is using compressed air he can explain the isothermal expansion curve, also the tension of gases.

He can tell you something in mechanics about matter and its properties, motion and velocity. He may tell you about the gases, their composition and densities; calculate the initial force of an explosion, explain deflagration and detonation, give the composition of blasting powder, tell you about the different makes of safety lamps and the principle of their construction.

He can tell you all about ventilation, the necessity for it, the quantity required, the laws governing the flow of air, can explain the motive column, the advantage of splitting the current, and tell about the regulator. He may be right at home when he talks about the various systems of inducing currents, whether it be by waterfall, steam jet, furnace or fans. He can tell you about the manometric efficiency of a fan, name the most prominent types of centrifugal ventilators in use, explain the purpose of the escape chimney, explain the equivalent orifice, and the use of the water gauge.

He can explain the different methods of working, can determine the size of shaft pillars, and why a draw is more likely to effect the alignment of a shaft than a slope; why slope pillars increase in width as they advance downward; what conditions of top and bottom require the largest pillars; state why squeezes frequently occur in slopes, and how shaft and slope should be sunk with respect to dip; what per cent. of grade is used in landings; why pillar drawing is delayed when the coal is soft; can explain the single-entry, double-entry, triple-entry, and longwall systems.

He can explain the different methods of hauling, and tell when it is economy to use a self-acting plane for hauling, and which is preferable, a two-rope system or an endless-rope system, and how the forces on an incline plane act in relation to each other to insure success, and on what class of roads can the tail-rope system of haulage be adopted with success. He can explain the principles of action of the endless-rope system of haulage; he can explain how a road bed should be made for underground haulage; he can tell what particular plant is required for a compressed-air locomotive haulage and what should be done in the pumping of compressed air to prevent waste of energy; can explain what difficulty would occur in using a gasoline locomotive engine for underground haulage in mines; can tell the advantages and disadvantages of the electric motor for haulage; can tell all about percussive and rotary boring; tell you the essential parts of a diamond drill, describe the hydraulic feed, the differential feed, and for what hand-power drills can be employed; describe the different methods of surveying a diamond drill hole, what the result would be of using a light hammer to strike a relatively heavy drill, and why.

He can tell you about coal-cutting machinery, what form of face is the most suitable for machine mining; for what kind of work shearing machines are best suited, and what depth of cut gives best results. He can tell you something about dynamos and motors, can calculate the power used from the reading of the ammeter and voltmeter, explain the alternating and constant current, and a thousand and one other things connected with mining I might go on and mention, but unless that manager has discipline in and around his mine he will fall short of success. It is true this knowledge I have mentioned will be a good sign of a trained mind.

System and discipline are so closely allied in operating a mine that you cannot have the latter without the former, therefore every mine should have some well-defined system so that every employe can understand that the mine is not run by guess or cut-and-try style.

Every prominent company realizes the importance of employing a competent engineer to survey and map its mines; some, of course, do not see the importance of going into detail and of having the room work surveyed as well as the entries, but this is a mistake. No miner should feel when he leaves the entry and enters his room that he has disappeared from the eye of the engineer. The miner should know he is not turned loose to do as he pleases, but that he is working under some plan and that he is expected to play a part in that plan.

When the mine boss, or whoever may look after that part of the work, goes to a miner's working place, he can establish a point in his working place, measure off distances on each side, tell him how near right his place is, and there is no guess work about it. He does not depend upon rapping on the pillars and guessing the distance as used to be the practice. The mine boss under this system is compelled to visit the miner's place frequently; he looks around and if he finds things as they should be he may have nothing to say, but if he finds things not right he can give instructions. When the above is practiced you have gone a long way towards discipline.

Every employe about a mine should be made to feel that he has a duty to perform and if he does not perform it in a proper manner some one will know it, while upon the manner in which he performs it will depend his future service. He should know he is expected to do his duty whether the manager is around or not, and that he must do everything he can to prevent injury to himself or fellow employe.

The management must impress upon the employes that he has an interest in their health and safety, as well as an interest in getting out cheap coal for the company.

There should not be too much changing around of employes. The longer an employe works at the same thing the more proficient he ought to be. There should not be any hurrying or fretting. No one person should be expected to do too much; he should have enough to do and do it well.

Usually around a mine the mine boss takes upon himself too much to do, and there is more danger of confusion from this than from anything else, and unless there is a great deal of care used he will be an overworked man, while the other employes will be underworked and the company's earnings will suffer.

It often happens that around a mine all you can hear is "where is the mine boss?" If a car is off the track "where is the mine boss?" If a mule has his shoe off "where is the mine boss?" If some one has a fall of slate "where is the mine boss?" Some one has water in his room "where is the mine boss?" and numerous other things I might mention. Then again you may visit a mine and see some track needs some repair, ask the track-layer why he don't repair it he will say "The mine boss hasn't told me yet." See a driver with car off ask him why he does not get it on, "waiting for the mine boss." See a brattice leaking and ask the fire boss why he does not stop it, "the mine boss hasn't told me yet," is his reply. See water in some one's working place, ask the pumper why he does not pump it out, "the mine boss has not ordered me to lay pipe in there yet."

In either one of these cases you can make up your mind the sooner that mine boss is disposed of the better it will be for all concerned. The mine boss should not be expected to look after every little detail such as I have mentioned as being present to see every car put on. He should be continually on the move to see that everything is being done in the proper manner; to consult and advise with the employes and give instructions for safety and economy. There is generally too much freedom allowed to employes; too much loafing away from their working places. Men congregate in places to tell stories and have a general good time. This should not be allowed, a man's working place is his place of business and he should go there and remain there except such time as he eats his meals. His mind should be on his work and he should see that his place is safe.

If men are allowed to gather in places to pass their time away, they are most sure to neglect their working place. They will go to their rooms when they get a car, hurry up and load it so as to get back for fear they may miss some story. They will not only neglect their own places and increase the risk, but will be in the way of drivers and increase the danger to others.

I adopted the following rule several years ago at the mine I am at, it is as follows:

All persons except those authorized are strictly forbidden to ride on any train, in or on any empty or loaded car, or on the cages in the mine.

No person shall be allowed to loaf on any gathering switch or around doors or shaft bottom, or to enter any abandoned places, except places that may be designated by the inside foreman.

It shall be the duty of every employe to go direct to their working places

* A paper read before the Ohio Mining Engineers, at the Columbus meeting, February, 1901.

and remain there until they are ready to leave the mine. If they have any business to transact away from their working places, they should go and transact it as expeditiously as possible and return to their working place.

Any one violating the above rules will have their turn stopped for one day and any one persistent in violating them will be discharged.

It shall be the duty of the foreman, motorman and drivers to enforce these rules. If they fail to do their duty they shall be laid off one day. If any employe knows of any dangerous place in the mine, or knows of any employe being reckless and exposing others to danger he will please report to the superintendent.

These rules are nearly all covered by the law of this State. There is one section of the mining laws of the State that every employe in and around mines should be familiar with. That is Sec. 6871. The mining department should have this section printed and posted in a conspicuous place.

The day men in and around the mine play an important part. While the miner has his working place and his safety depends mostly upon himself, the day man has generally the safety of others as well as himself, therefore it is necessary for the management to keep in close touch with them.

Whenever the management discovers any recklessness on the part of any employe he should be changed to a place where that recklessness could not affect others, or to a place where it could least affect others.

There is no question that the better discipline the less danger of accidents and better results from the labor employed.

BLACK SAND

Auriferous Deposits of Wreck Bay, Jordan River, and Other Localities of Vancouver Island.

Written for MINES AND MINERALS, by R. Lind Watson.

For years, it has been known that deposits of auriferous black sand occur at intervals along the northern and western coasts of Vancouver Island, but until last summer the difficulties in the way of saving the gold were believed to be insuperable. The fallacy of this belief was demonstrated at Wreck Bay in the summer of 1900, when about \$12,000 was taken from the black sand claims.

Wreck Bay is situated north of Barclay Sound and about five miles from Amphitrite Point. It extends three miles along the coast and one mile inland, and may be reached by a trail from Ucluelet Arm, the distance being two and a half miles. The beach is exposed at low tide and consists of black sand mixed with ordinary sand and gravel. A flume two miles long conducts water to the beach for washing the sand. An ordinary sluice box is used for saving the gold; and in the bottom of the sluice box, silver-plated copper plates mercurialized are laid, the plates being of the same width as the sluice box. A heavy wire grizzly is placed at the charging end of the sluice box to keep back the gravel and allow the passage only of the sand with its precious contents. One of the difficulties met with in saving the gold is that much of the sand is garnetiferous, and the specific gravity of the garnet is so heavy that scaly gold is unable to work its way by gravity through the sand, and so passes out of the box and is lost.

East of the mouth of the Jordan River and about forty-six miles west of Victoria, there is what appears to be an old river bed. The river was probably a glacier stream, and the material which it carried derived from the graphitic slates which extend in a somewhat narrow belt from the Jordan River in a southeasterly direction to Esquimalt Harbor, outcropping at Goldstream and Langford Lake. These slates are probably of Triassic age and analogous to the rocks found at Boston Bar in the Fraser River and in the Cariboo, Columbia, Omineca, Purcell, and Selkirk mountains. Stringers of quartz which frequently carry gold occur in the slates. The placer deposits of the Jordan River are therefore most likely an accumulation from large denuded areas of these rocks.

The formation from the Jordan River eastward towards Sooke consists of clay, sandstone, and conglomerate of Tertiary age. For a considerable distance from the mouth of the Jordan, the shore is 25 feet to 100 feet high and composed of blue clay. The beach between the clay and the water line is composed of black sand; while along the top of the clay cliffs there is gravel heavily stained with oxide of iron for a thickness of three to ten feet. The gold in this gravel is not visible to the naked eye, but by panning, the black sand becomes concentrated and from it the gold can be easily removed.

Near the mouth of the Jordan, the sand is two feet to three feet in thickness and pans from top to bottom, though best values are found at the bottom near the blue clay bed. A probable average would be fifty cents per ton of sand. The deposits could be easily worked, so operations might be carried on at very little expense.

Two good creeks empty into the straits at the beach, thus affording an ample water supply and rendering only a short flume necessary. The gold is in small particles and well rounded and could readily be saved if a long sluice box were used with a wide

amalgamated plate at the discharge end, so arranged that the material would be evenly distributed over its surface. An even distribution might be effected by having a distributor shaped like a hand with fingers outspread placed at the discharge end of the sluice box and pointing towards the plate.

Work can only be carried on during the low tides of spring and summer.

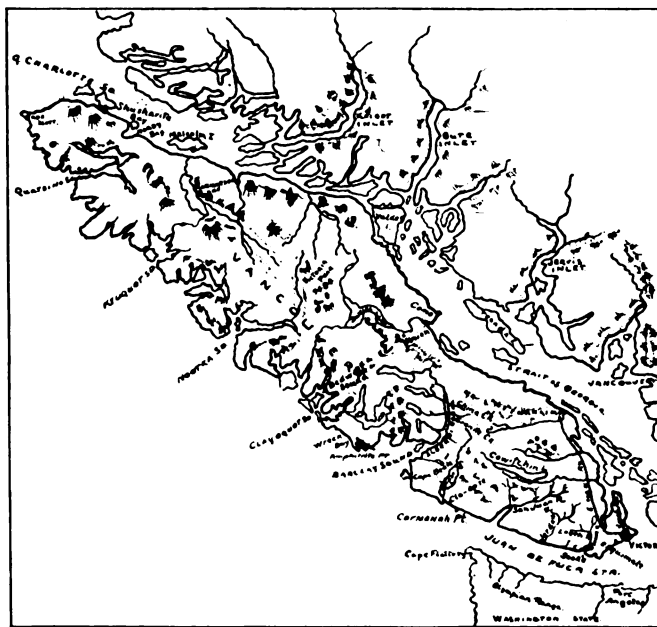
At the Clo-oose Indian Rancherie, between Carmanah Point and Nitinat Lake, there is a limited area of black sand which has not as yet been worked commercially. Unfortunately the beach is a poor one for landing, because it is exposed to the breakers of the ocean.

Colors of gold may with truthfulness be said to occur in almost every stream of Vancouver Island. At Leech River, China and Granite creeks in the Alberni District, and at Bear River, placer mining has been engaged in.

Leech River was discovered to be auriferous in the sixties, probably 1868, by a government exploring party in charge of Peter Leech, L. S., and in a short time gold was washed to the value of \$100,000. Gold was found in the river for a length of five miles and was obtained from the bed of the stream and from fissures which occur in the slates which form the sides of the valley. A cement-like substance formed of sandy clay solidified, seemingly by great pressure, lines the bed and sides of this V-shaped valley. The cement is yellowish-gray in color and contains subangular stones, and represents, in all likelihood, the bottom moraine of a glacier. The placer miners did not penetrate beneath this cement to discover whether or not values existed on the true bed rock. At the confluence of the Sooke and Leech rivers, there is a bench 13 feet to 20 feet above the river, and known as Kennedy Flat; on it Leechtown was located. Though for a time this was a prosperous camp, it is now deserted.

Scales of gold are found on all the bars in the Sooke River, and near the mouth of the river a rich occurrence of gold has recently been discovered.

About the time when Leech River was commanding attention, China and Granite creeks, tributaries to the Alberni



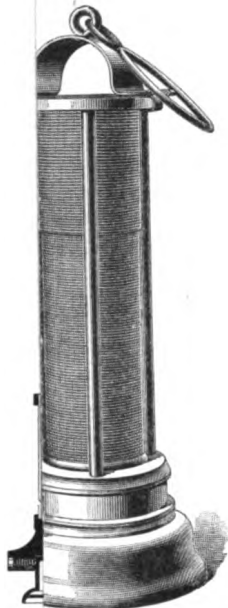
MAP OF VANCOUVER ISLAND.

Canal, were found to be auriferous. Hydraulic mining succeeded placer mining but was rendered unsuccessful by the presence of large boulders. At the present time, there are two hydraulic plants lying idle in the district. The spurt given at the initiation of hydraulic mining led to a thorough prospecting of the district and recording of mineral claims, so that quartz mining became the next phase of the work. Though the quartz contained high values in gold at the surface, it became barren at a slight depth, so work was abandoned. Later it was learned from smelter returns and from assays, that the quartz even at depth carried, in places, good values. In the coming summer work will be resumed in the Alberni District.

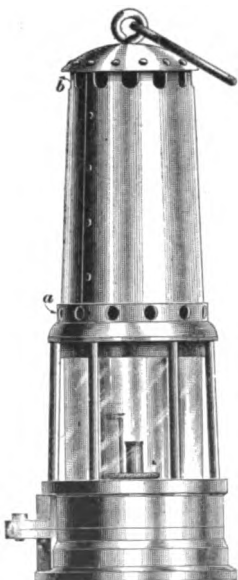
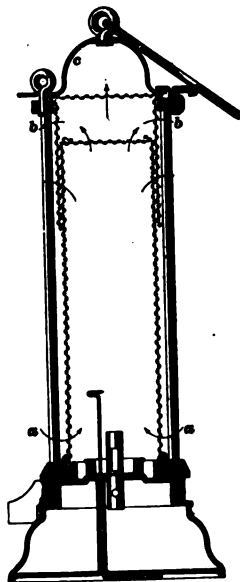
At Bear River, which flows into Bedwell Sound, placer mining has been carried on for about twenty-five years. The gold seems to have been derived from stringers of auriferous quartz occurring in granite. Eight miles from the mouth of the river, Chinamen washed for gold until about two years ago, when they were frightened away



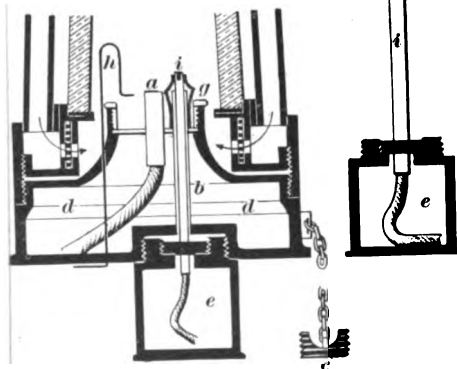
MUESELER LAMP



DAVY LAMP.



EVAN THOMAS LAMP.



STOKES LAMP.

because three of their number died. As in the Alberni District, boulders are a difficulty in mining.

Gold is reported to have been found in streams flowing into Kyquoot, Nootka, and Quatsino Sounds. At Cape Scott, the most northerly point of Vancouver Island, it is also found, but of so fine and flaky a quality as to be difficult to operate.

East of Cape Scott, and eight miles north of Shushartie Bay, there is a deposit of black sand which was discovered several years ago. The area is limited, being cut off at either end by cliffs. Miners left Victoria very recently bound for this place, taking with them lumber with which to construct a flume. Auriferous black sand is not confined to Vancouver Island, but is also reported to occur on the beaches of the Queen Charlotte Islands and those near Cape Flattery, Washington State.

Electric Locomotives.

The coal operator who opened his mine but a few years ago, and employed mules for hauling his coal, soon found that some quicker means was necessary for delivering coal to the tippie. The convenience and simplicity of electric haulage was early recognized, and the increasing demand for electric locomotives is ample evidence that they have met every requirement of the mine.

The necessity for locomotives of large capacity has grown with the output of the mine, but the original low and narrow entries have proved a serious obstacle to their use.

To meet the demand for a locomotive of large hauling capacity and yet of so compact a form that it can be used in the average

brakes are operated by a screw which is keyed into the hub of the hand wheel. No ratchets and pawls are necessary for locking this brake mechanism as the screw makes it self-locking in any position. The mechanical advantage is such that the operator can easily skid the wheels of the locomotive.

Sand boxes of large capacity are provided at both ends of the locomotive, and the operating levers for the sand valve are placed within convenient reach of the operator.

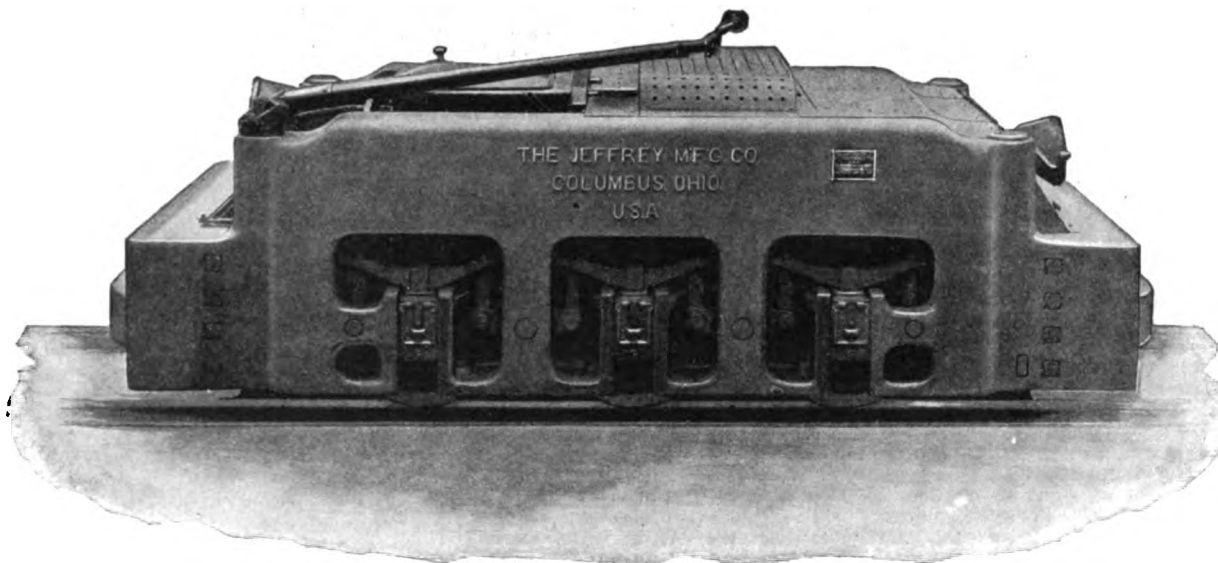
The motors are water- and dust-proof. They are wound for either 220 or 500 volts. The motor frames are of cast steel, designed to meet the exacting requirements of mine service. The armature shafts are made of high grade crucible steel and both the armature shaft and axle bearings are made of the best bearing bronze obtainable, carefully bored to alignment and scraped to fit before assembling. The commutators are made of drop forged copper segments insulated with the best mica.

The controller used on the locomotive is the Jeffrey Class 9. It has specially large, milled contacts, and is so arranged that the motors may be run either in series or in parallel. The operating levers are conveniently located.

The resistance coils, which are of ample capacity, are located at the top of the locomotive, and so arranged that there is a constant circulation of air about them, which keeps them cool.

On either side of the locomotive frame is a cored receptacle for the Jeffrey standard trolley base which admits of the trolley pole being placed to suit the mine wiring.

Every motor used in the Jeffrey locomotives is given a full load and overload test before placing on the locomotive. After the



JEFFREY 20-TON ELECTRIC MINE LOCOMOTIVE.

entry, the Jeffrey Mfg. Co., Columbus, Ohio, has brought out among its later designs the 20-ton locomotive shown in the illustration.

The rated drawbar pull of this locomotive is 8,000 pounds. The speed ranges from six to ten miles an hour depending on the load. Under test the locomotive developed over 11,000 pounds, drawbar pull, before the wheel slipped. The motors, however, are of ample capacity to skid the wheels on the best track when using sand.

It is equipped with three 60-H. P. motors, each geared to an independent axle and pair of drivers. Dividing the power between three motors effects a great saving in the width and height of the locomotive over one of the same capacity having but two motors.

The drive wheels are pressed on, and keyed to special hammered open-hearth steel axles. The wheels themselves are of the open plate cast-iron type with chilled tread. The axle journal bearings are of a type which meets the approval of the Master Car Builders. They are made of a very tough and durable bearing metal, and are of sufficient size to make the pressure on the journals well within the safe limit. The wheels being inside the locomotive frame, the axle journal bearings are accessible for oiling, or for renewing the linings. The journal boxes are dirt-proof, which insures long life to the bearings.

The frame of the locomotive is of massive iron castings, rigidly bolted together with heavy steel bolts, and supported by equalizing leaf springs, which rest in suitable chairs on the journal boxes. The frame covers are of sheet iron, hinged in such a manner as to allow easy access to all interior parts of the locomotives.

The brake mechanism is very simple but effective. Pressure on the six brake shoes is equalized by a system of levers. The

locomotive is complete it is placed in a special testing frame and made to run the equivalent of several miles under load in both directions. It is also subjected to a series of severe electrical and mechanical tests in order that any defects of any sort may be discovered before shipping.

The locomotive shown in illustration is the largest and most powerful electric locomotive for mine use which has yet been built. Already a large number of them have been put into service. The Jeffrey Mfg. Co.'s line of electric locomotives is very broad, making as they do locomotives running in weight from 2 tons to 20 tons suitable for use in mines of all kinds, smelters, mills, and factories.

How should cables on main roads be fixed? The writer does not like to see cables lying about on main roads, as is so often the case. Every alteration to the road, and everything that happens, is a source of trouble to the cables, which is, unfortunately, not found out till later on, and it is sometimes difficult to unite cause and effect. In his opinion, if it cannot be arranged to place them well out of the way in any other manner, they would be better placed in troughs by the side of the road, the troughs being made of wood and filled in with pitch. There are two things to be guarded against in connection with cables in mining work, mechanical injury to the insulating envelope of the cable, and the action of moisture upon the insulating envelope. Both of these can be provided for in the manner suggested, as the cable can be always got at for inspection, and can be closed up when the inspection is finished. Pitch also possesses some of the properties that glacier ice is stated to possess: it will follow the variations of the ground without opening a passage for the moisture.—Colliery Guardian.

FAILURES OF SAFETY LAMPS

Whilst in Use, Some of the Disasters Caused Thereby, and Lessons Which May be Derived from Them.

By Mr. James Ashworth, M. E.*

Papers to this and kindred societies on the subject of safety lamps have during the last few years, and in fact ever since the report of the Mines Accidents Commissions was issued, consisted principally of descriptions of improvements in construction and simplification of parts, but the writer does not remember one which has had direct reference to a common danger which has hitherto remained unrecognized in this country. It is therefore with a view to showing that the laboratory experiments of M. Marsaut on the influence of firedamp when a safety lamp is suddenly immersed in it, or when, what is practically the same thing, firedamp suddenly envelopes a safety lamp, have had a very practical confirmation in the mines of this country and yet received no genuine attention, that the writer has prepared the present paper for discussion. In all English experiments most attention has been given to the discovery of those lamps which would give the best results when exposed to a high velocity of an explosive mixture of firedamp and air, under the impression that a lamp which will successfully withstand such tests must be capable of withstanding any exposure in a quiescent or slowly moving current. M. Marsaut, however, took a very different view of the case and made a very large number of experiments on safety lamps when suddenly raised into a firedamp atmosphere, but so little value was placed on these experiments by our own Mines Accidents Commission, and by other experimenters since, that practically nothing has been done to support or disprove M. Marsaut's conclusions. Some emphasis is given to the importance of making safety lamps capable of withstanding very ordinary risks by the report of a recent inquiry in Germany, which will be detailed, and which will also introduce the question of the advisability of relighting safety lamps as soon as extinguished, by match arrangements within the lamp.

As a preface to the detailed descriptions of places and conditions surrounding safety lamp failures, it is to be observed that no explosion or great disaster caused by firedamp is so difficult to bring home to its primary cause with any degree of conviction as that caused by, or originating from, the failure of a safety lamp, because the traces of failure are either very faint or entirely absent, if the traces looked for are principally indicative of overheating, but fortunately we have authentic records of failures where the users of the lamps, or the men near by, have seen the failure occur, and have lived to tell the tale. Moreover, where the failure of a safety lamp is complicated by the presence of coal dust, the appearance of the lamp becomes still more misleading, as the gauze will be found extremely clean, and very probably showing little or no signs of overheating; thus a lamp passing the flame through the gauze when tested in an experimental gallery with a mixture of air, firedamp, and coal dust, at so low a velocity as 370 feet per minute, never becomes so hot as when firedamp only is present. This fact is probably due either to the formation of a large percentage of carbon monoxide within the lamp, or to the fact that the particles of coal dust are so small as to become incandescent in the burning mixture within the lamp, and to pass out in a regular stream of fire. Extremely few experiments have been made with safety lamps exposed to various velocities of mixtures of firedamp, air, and coal dust, and none whatever by any Government Commission, probably under the assumption that a lamp which will stand a severe testing in gas and air will stand equally secure if coal dust is added, but that this assumption is erroneous will be clearly demonstrated by the facts now tabulated.

Davy Lamp Failures.—On the 30th of March, 1873, two men were at work in an airway of the Old Mine at Bardsley Colliery, Ashton-under-Lyne, when an outburst of firedamp came off at a rent in the floor, and mixing with the air current ignited in the men's Davy lamps, and as they entirely failed to extinguish the flame, it quickly passed the gauze with the result that both men were burned and one of them was killed. The survivor told Mr. Dickinson, to whom I am indebted for these particulars, that "they tried but failed to put out the flame in the lamps, and that the best science man could not have done more than they did."

Another failure of an unbonneted lamp is described by Mr. A. R. Sawyer, late H. M. Assistant Inspector of Mines for North Staffordshire, in a paper he read before the North Staffordshire Institute of Mining and Mechanical Engineers, on the Marsaut safety lamp. On the 20th of February, 1883, in the Great Row seam of coal at Great Fenton Colliery, he took up a Davy lamp which was hanging at the face in a slightly dusty working,

and gave it a tap with his hand, and in an instant there was a reddish flame of some magnitude inside the gauze, extending to a distance of about 2 inches outside the gauze of the lamp. Mr. Sawyer was so surprised that he says he should have thought it an optical delusion had it not been seen by the underviewer as well as by the collier to whom the lamp belonged. Two out of eleven explosions, by which one or more persons were killed, which had occurred in his district during the preceding five years, and as to which he could speak personally, were caused by the ignition of gas at a perfect Davy lamp. (The writer observes that Mr. Sawyer does not say anything about the influence of dust in the case of these failures.) He also named two instances, one in 1883 and another in 1884, when the accidental spilling of some gunpowder dust on the gauzes of Davy lamps caused the flame to pass the gauze and fire the bulk of the powder which was being used by the colliers.

Another Davy lamp failure caused an explosion on the 13th of August, 1886, at the Wood End pit of the Bedford Colliery, in the Crumhouke Mine, 3 ft. 8 in. thick, by which 38 lives were lost. In the morning men were engaged in one of the stalls taking out the back props, and after stopping for breakfast gas was discovered coming off out of the gob, but, without reporting it, they went on with their work. About 10:45, whilst a collier was loading some coal out of the way of the timbermen, gas was seen to fire in the Davy lamp, which hung from his waist strap and was swinging between his legs. The lamp was provided with a tin shield about three inches high, surrounding two-thirds of the gauze, but at this time was pushed up to the top so as to give more light, and as soon as the collier was warned that gas was blazing in his lamp, he took it in his hands and commenced to blow at it, then shook it, and the flame passed to the outside and fired the mine. The collier was not burned, but killed by suffocation, whilst the timberman who saw the occurrence and got out alive was only badly burned; the other timberman was also burned, but succumbed after running about 80 yards.

Davy Lamp With Tin Shield Failure.—At the Bryncoch No. 1 Main Colliery, on the 4th of August, 1896, the Graigola seam of coal (5 ft. 4 in. thick) was being worked at a depth of 435 yards by the pillar-and-stall method. One of the pillars on the north side of the shaft had been partly removed, and, on the morning of the accident, the strong rock roof began to break down where the pillar had been removed, and as it did so released a large volume of gas from a seam of coal which lies 19 yards above. The gas after a time came off in so large a volume that the colliers' lamps were extinguished, and the intake air was pushed back to the separation doors on No. 1 N. E., Fig. 1. Three colliers who were working at the top end of No. 2 S. E. had their lamps extinguished, and instead of at once escaping, two of them, Nos. 6 and 7, sat down whilst the other, No. 5, went for fresh lamps. On his return with another man and whilst running, the Clanny lamp was extinguished by the gas and was thrown away before they got to the two men who had remained in the workings, and who did not respond to the shouts of their would-be rescuers. They then returned to the level, where they met some colliers going outbye; from these they obtained two fresh lamps and also another volunteer, and again attempted a rescue, but with the same non-success as before. Whilst groping their way out they met two firemen, Nos. 3 and 4, and a repairer, No. 7, each with a lamp, and two of them, Nos. 2 and 5, again turned back to assist in the rescue. The two firemen carried naked Davy lamps furnished with small tin shields which surrounded about one-half of the circumference and about one-third of the height of the gauze, and the other man carried an ordinary unshielded Clanny. The leading fireman hurried in, and from the statement of one of this party, No. 2, who survived for several days, they were all turning back when the explosion occurred. Every man dropped his lamp, the Davy lamp of the leading fireman, No. 4, being found the furthest in, and bearing unmistakable signs of over heating. Shortly before the explosion, and without knowing what was being done in No. 2 S. E., the under-manager opened the separation doors in No. 1 N. E. so as to break up the body of the gas which had backed down from the fall in the pillar working, and was showing itself on the intake side of the doors. By doing this he not only moved the gas, but he also shortened the air course and thereby increased the velocity and the volume of the ventilation in No. 2 S. E., which though normally 1½ ft. per second, became 6 ft. per second, or enough, with adding the increase of velocity due to the movement of the retreating fireman against the air current, to cause the failure of any of the lamps in use. The verdict of the jury was to the effect that the gas was accidentally lighted by a partly protected Davy lamp; and that they had heard with satisfaction that the owners had dispensed with the partly protected Davy lamp and adopted a safer lamp for future use, viz., the Cambrian bonneted fireman's lamp.

It must again be noted in connection with this accident that although coal dust was not noticeably a factor of the explosion,

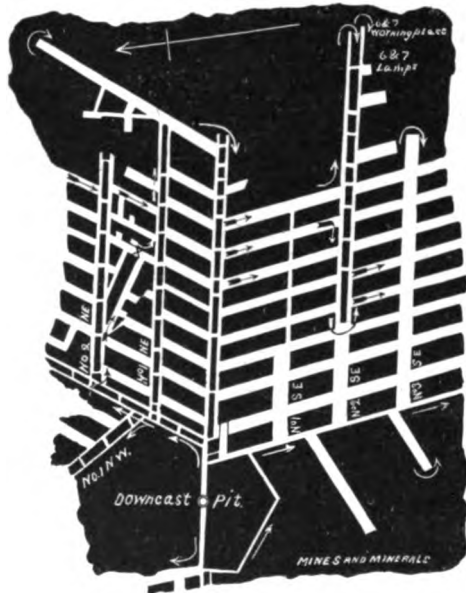
* A paper read before the Manchester Geological Society, Manchester, England.

yet that a very thin deposit of gray colored dust was found after the explosion on the whole of the surfaces from the downcast shaft along the south heading, and in from No. 2 S. E. southward to the main return leading to No. 2 pit. This latter element of gray dust was supposed to have been driven out of the gobs, but whether produced by the increase in the velocity of the air current, that is from $1\frac{1}{2}$ ft. to 6 ft. per second, or by the explosion, it is impossible to say with certainty. If, however, it were produced by the former cause it would exert an important influence on the explosibility of the gaseous mixture, as was proved by Professor (Sir) F. Abel in the course of the experiments made by him on dust after the Seaham explosion.

The influence of dust having been so clearly demonstrated, it is obvious that experiments which are made to represent, as nearly as possible, the conditions of a colliery roadway or stall must be incomplete without its inclusion. Also that sudden increases in the velocity of ventilative currents, as well as sudden increases in the percentage of gas, must be factors to be considered.

Failure of a Stephenson Lamp.—On the 4th of August, 1885, in the Middleton Mine of the East Ardsley Colliery in the early morning, the night deputy found a fall, which interfered with the free passage of the air through one of the banks, but no gas, and as a precaution he ordered the collier who was going to work in the next bank on the outbye side to take a Stephenson lamp instead of the Clanny which he ordinarily used. About 9 A. M. the day deputy found a little gas, but did not tell the collier, and about twenty-five minutes past two, whilst the collier was moving his lamp to hang it on a prop or place it on the pack wall, the gas which had accumulated overhead fired through his lamp. The

collier was very badly burned, and afterwards died, but the pony driver who was in the horse road and also badly burned, recovered. In this case the failure was probably due to the reversal of the air current within the lamp, caused by the upward diagonal movement, and experiment has proved that when such a reversal takes place the flame is crushed down on to the wick, the lamp fills with gas from the top, and as soon as this touches the flame the resulting explosion is so violent, being confined



by the long glass cylinder, that it passes through the copper cap and the surrounding gauze without any perceptible delay. It is probable that some coal dust was also present, as the collier had been loading coal into a tub just before the accident happened.

Failures of Clanny Lamps.—On the 19th of May, 1894, at the Albert pit of the Allerton Main Collieries, five men—viz., the under-manager, a deputy, and three miners—were engaged in making preparations to remove some firedamp which had accumulated in the end of the east bord of the Silkstone seam of coal, above a fall of roof in broken ground where there was also a rise fault of 12 ft. They first of all erected a fan at the end of some wooden pipes, 12 in. square and 21 ft. long (which had been used to ventilate the heading), so as to blow the air directly into the gas, and thus clear it out with the least possible delay. Soon after starting the fan they found that one of the pipe joints was defective, and the under-manager and deputy proceeded to take off the brattice cloth which covered it, preparatory to putting in a new pipe, but almost as soon as they had commenced an explosion took place, and all five men were burned. Four of these men had Clanny safety lamps with metal bonnets, gauze caps to the main gauze, and the inlet air ascending vertically through holes in the middle ring, as is customary in most modern safety lamps, but the fifth man had a lamp with a tin shield, and the inlet-air holes $\frac{1}{2}$ in. in diameter, placed in the side of the shield near its base. It will be seen, therefore, that the gauze of this latter lamp was imperfectly protected from the direct effects of an air current, and as it was the lamp used by the under-manager and deputy when removing the brattice cloth from the

joint, it was surmised that the lamp was close to the joint, that it was in a gas-charged atmosphere at the time, and that as soon as the brattice was removed a current of air of high velocity rushed out of the joint, and forced the flame of the burning gas through the gauze, and thus originated the explosion. None of the safety lamps were damaged in any way by the explosion and were found securely looked.

Following the failure at Allerton Main, a more serious explosion occurred from a similar cause on the 1st of October, 1895, at Shakerley Colliery, Tyldesley, in the Trencherbone seam of the Wellington pit, whereby five lives were lost. These were (1) the manager, (2) the under-manager (3) the day fireman, (4) the night fireman, and (5) a dataller, all of whom were reported to have been very badly burned. No. 1 had a bonneted Clanny lamp, locked by a screw, and burning colza oil; Nos. 2 and 3 had similar lamps, but on examination after the explosion it was found that the gauze of No. 3 showed marked signs of having been much heated—in fact red hot. It was furnished with a loose shield round the gauze, the oil vessel was not tight, and it took only two and three-quarter turns to screw it up. The glass was 2 inches in diameter, the top and bottom ends being so carelessly ground that they were $\frac{1}{4}$ th inch out of parallel and at one point the light could be deflected by blowing between the glass and the asbestos ring. The gauzes were made of copper wire, and were found to be badly seamed, the main gauze being $1\frac{1}{2}$ in. in diameter and $3\frac{1}{2}$ in. long, surmounted by a gauze cap $1\frac{1}{2}$ in. long. The products of combustion escaped through holes in the circumference of the shield as well as vertically through the gauze cap, which was protected by a semi-circular hinged or tile top open at both ends. Nos. 4 and 5 had Protector Company's bonneted Marsaut lamps, locked by lead plugs, and burning colzalene spirit. All the lamps were found intact after the explosion. The circumstances leading up to this explosion were as follows: Gas having accumulated in one of the districts of the Trencherbone Mine an attempt was made to clear it out, but this failing, the manager, accompanied by the four men before named, went to remove it. The only air current available for this purpose came from the Nelson pit through a very small airway, and it has been estimated that it did not exceed 1,000 cubic feet per minute, that this small quantity was further reduced by part of it escaping down the first brow, and that its velocity did not exceed 2 ft. per second. At the point where No. 3's lamp was found the level was 6 ft. wide by 3 ft. 9 in. high, and divided by a brattice cloth placed 2 ft. from the higher side, the lamp standing on the return side and therefore in the larger space. The positions in which the other lamps were found led to the surmises, (a) that all the lamps excepting No. 3's had been extinguished; (b) that No. 2 went forward past the end of the brattice without a light to remove some obstruction, and was rendered insensible by the gas; (c) that No. 1 rushed in to his rescue, and when only 8 ft. beyond the lamp he had left behind, the latter passed the flame, and all were immediately killed by the succeeding explosion. This reasoning indicates that disturbances of gas and dust by such movements as those of Nos. 1 and 2 are quite sufficient to cause the passage of flame through similar lamps, when the gauzes are already overheated.

Failures of Muesclers.—On reference to M. Marsaut's experiments it will be found that a Mueseler is not always a safe safety lamp in a quiescent atmosphere of air and firedamp, because it sometimes communicates the explosion to the outside by internal explosion in a stagnant explosive mixture, and it was this fact which mainly brought him to the construction of the lamp known as the Marsaut.

Mr. E. B. Wain, C. E., the general manager of the Whitfield Collieries, Stoke-on-Trent, has kindly furnished the writer the following particulars of the failure of an unbonneted Mueseler which occurred on the 9th of February, 1886, in the Cockshead seam of that colliery.

An old road was being crossed which was very dusty, having been on fire five years previously.

A man was at work with a typical Belgian Mueseler hung up on a prop near the roof, and another Mueseler of English make was hung up in a similar manner a little further down the heading. A small fall of dirt, Fig. 2, took place from a hole in the roof of an old level where a small quantity of gas was lodged, and thus brought down this gas on to the nearest lamp which immediately fired the mixture, both within and outside the lamp, resulting in an entirely local explosion and slight injuries to the man. After the explosion the lamp was found to be in a perfectly sound condition and the gauzes as bright as silver, whereas the other lamp was found covered with dust, thus clearly showing that the explosion within the first lamp had cleared all the dust away.

Mr. Wain says he had only left the place a few minutes when the accident occurred, and that it was the very dustiest place he had ever seen in a coal pit, the dust consisting principally of bind and shale which had been intensely heated.

He was also of opinion that under like conditions a bonneted Mueseler would fail in like manner. (With which opinion the writer entirely agrees.)

Failure of Marsaut Type Unbonneted (2 Gauzes).—The writer is indebted to Mr. Ronaldson, the Chief Inspector of Mines for the Western District of Scotland, and his assistant, Mr. Pearson, for the following particulars of the failure of an unbonneted Marsaut.

On the morning of the 19th of March, 1895, at No. 2 pit, Dalziel, Lanarkshire, worked by the Wishaw Coal Co., one of the fireman in the ordinary course of his examination of the pit before the men went in to work, found an accumulation of firedamp about 30 ft. long, in a narrow heading which was being driven through a troubled piece of coal in the Splint seam, at a point about a mile from the pit bottom. This place was imperfectly ventilated by bratticing, when not assisted by the exhaust air from a pumping engine situated about six chains back from the face. The gross pressure of the air was about 40 lb. to the square inch, the pipe conveying the exhaust air from the engine to the face was 1½ in. in diameter, and terminated about 15 ft. from the face. The pumping engine having been standing for some hours in consequence of repairs to the compressor, firedamp had accumulated, and as the colliers wanted their tools to work in another part of the pit, the overman, fireman, and one collier went in with safety lamps to fetch the tools. Whilst the fireman was in the act of putting up his lamp to the roof to test for gas, the engine was suddenly started, and the exhaust air issuing at a high velocity directly on to the lamp, which was already surrounded by gas with only a slight admixture of air, forced the gas so suddenly into the lamp that it was completely filled, and when ignited by the wick flame (which was probably reduced for testing), the violence of the resulting explosion was so great that the gas flame passed right through both gauzes. The accumulated gas thus ignited caused injuries to the overman, fireman, and two colliers, one of the latter being some distance away. The overman was watching the fireman making the test for gas, and distinctly saw flame pass out of the lamp. The lamps used by the overman and fireman were afterwards found on the ground, and were in good condition and so little heated that there was nothing to show which lamp had failed. The velocity of the air issuing from the exhaust pipe was measured by an anemometer, and found to be 600 ft. per minute at a distance of 6 ft. from the pipe, and at a distance of 3 ft., 1,600 ft. per minute. The whole pit was worked with safety lamps, and the lamps used by the overman and fireman were Protector Company's unbonneted Marsaut's of the following dimensions: Outer gauze 4½ in. long by 2½ in. diameter at the base and 2½ in. at top; inner gauze 1½ in. in diameter at the base and 1½ in. at the top by 3½ in. long; glass 2½ in. diameter by 2½ in. long. These dimensions are a little in excess of those adopted by M. Marsaut. The gauzes were flanged at the base but were not strengthened by copper rings riveted to their base. The heading where this explosion occurred being thoroughly wet from water issuing from the coal and roof, coal dust was not a factor in the explosion, nor is it probable that it was present in the compressed air, as the screens were not at work and the compressor was fifty-five yards away from them, but it is possible that firedamp had accumulated inside the pipe as well as around it, and was forced onto the gauzes at a velocity of between 10 and 27 feet per second.

Failure of Marsaut Type Lamp (Containing Self-Lighting Apparatus).—In consequence of an explosion of fire-damp in a section of the Olga seam of the shaft of the Kaiser Heinrich Ferdinands Nordbahn Colliery, the origin of which accident was unknown, Bergrath Meyer, *Oesterreichische Zeitschrift für Berg-und Hüttenwesen*, was deputed to investigate the matter with a view to discovering the reason for the explosion.

The section in question is the most fiery portion of the colliery, and is situated between two extensive faults. The seam is about 68 in. thick, the slope 30 degs., and the volume of gas liberated about 1,110 cubic feet in twenty-four hours for each ton of coal hauled, a quantity about equal to that of the most fiery pits in the Karwin district. The percentage of firedamp in the expelled ventilating current is sometimes as high as 0.75 per cent.

At the time of the explosion a hewer was engaged in trimming out a position for the erection of some timbering, by the light of a Wolf benzine lamp of the old type, with double gauze and percussion igniter. Although it was evident that the firedamp was ignited by this lamp, the immediate cause could not be ascertained owing to the contradictory statements of the miner, and the matter remained in doubt until a series of laboratory experiments indicated the possibility of the ignition being caused by the direct impact of a sudden rush of gas from the coal against the lamp, though the latter was in perfect order.

The hypothesis that the ignition might have occurred through an outburst of flame from the lamp in consequence of the combustion of some of the ignition pillules on the lighting strip inside the gauze, was shown to be highly improbable by the tests made

with the same lamp in a Schondorff apparatus, the lamp being lighted in an atmosphere containing 7 per cent. of firedamp and moving at a velocity of 5 to 6 yards, as also by the simultaneous combustion of eight of the pillules within the lamp in an atmosphere charged with 10 per cent. of firedamp. No outbursts of flame could be detected, although Spoth's experiments, made under more stringent conditions, showed that such outbursts from safety lamps are not impossible.

The following possibilities were assumed as the cause of the explosion:

(a) Rapid movement of the lamp and sudden contact, whilst charged with burning firedamp, against some hard object, either above, below, or in a horizontal direction, with or against the ventilating current.

(b) Contact of shreds of clothing against the heated or glowing gauze in an attempt to extinguish the lamp. It should, however, be observed that, from the condition in which the lamp was found after the explosion, it is improbable that the gauze could have been red hot.

(c) An outburst of flame from the lamp in consequence of the ignition of the pillules of the lighting apparatus, at the time of lighting the lamp, or withdrawing the pillules while the lamp was burning.

(d) Through the influence of an outburst of gas directly impinging on the safety lamp.

Each of these four possibilities was investigated in a series of laboratory experiments which furnished highly interesting results:

(a) In this series it was found that explosions are of frequent occurrence when the percentage of firedamp exceeds 6 per cent. and the velocity is over 23 ft.

(b) Here ignition first takes place in a 5 per cent. firedamp mixture and at velocities above 13 ft. In the series a, d, c, no ignition occurred in lighting the lamp by the ignition pillules, even at velocities up to 39 ft. and in 7 per cent. firedamp mixtures; neither was any outburst of flame from the lamp produced when 5, 10, 20, and even 72 pillules (the entire strip) were set off at once. No outbursts ensued on igniting the pillules in a 7.15 per cent. firedamp mixture and at the high velocity of 32 ft.; and only when the pillules were burnt away in five seconds, with the lamp exposed in the current for ten seconds, did any passage of flame to the outside occur.

The divergence between these results and those obtained by Spoth can only be explained by the supposition that Spoth obtained his ignition pillules from another source, and that they contained a stronger charge of fulminate. The condition of the lamp in question and of the appertaining strip after the accident was, however, such as to indicate some other cause for the explosion.

The circumstances are different when pillules are set off whilst the lamp is burning; in this event ignition occurs—though not regularly—readily at velocities of 20 to 23 feet, and in presence of 7 per cent. of methane. The friction igniter also produces ignition under similar circumstances in 7 per cent. methane mixtures, and at velocities of 24 to 25 feet.

The fourth series of experiments with gas outbursts, which are somewhat difficult to imitate in the laboratory, showed that in the case of gaseous mixtures with a velocity of 16 to 19 feet the light was invariably extinguished. On the other hand, in a quiescent atmosphere the impinging of a methane-free current at a velocity of 13 to 19 feet, frequently caused the flame to burst out, and this is the most probable cause of the explosion at the Heinrich shaft, more especially as similar outbursts are characteristic of this section of the seam, and the phenomena described by the miner coincide with what might be expected to happen from an outburst of this kind.

CONCLUSIONS.

The safety lamp failures of which the writer has given particulars are, he thinks, sufficient both in number and detail to prove to the most skeptical mind that there is every possible difference between the margin of safety possessed by a safety lamp when exposed (1) to an atmosphere of firedamp and air, and (2), to one composed of mixtures of firedamp, coal dust, or other dust and air. Thus the case related by Mr. Sawyer shows



that under certain conditions flame may be passed through the gauze of a safety lamp with the aid of coal dust, without causing the explosion of the surrounding atmosphere, but fire-damp mixed with air may be exploded many times in a similar lamp without much risk of passing the flame. When, however, these two dangerous components are coupled together the danger is greatly intensified, and such occurrences as Shakerley and Allerton, etc., become both possible and probable. The vast importance of knowing what is the margin of safety, if any, is evidenced by the experiments made by Mr. Hilton, at the suggestion of Mr. Gerrard, H. M. Chief Inspector of Mines for the Manchester district, on the bonneted Clanny lamp, which failed at Shakerley. Mr. Hilton conducted these experiments in a testing gallery belonging to the Wigan Coal & Iron Co., Ltd., which is in all respects like the one used by Mr. Rhodes at Aldwarke Main, and he also made the conditions approximate as nearly as possible to those of the mine, but no explosion resulted, although the time of exposure of the lamp to an explosive mixture of coal gas, and air varied from two to thirty-seven minutes. Further experiments were made in a still, inflammable atmosphere, and continued for twenty minutes, but no passage of flame resulted, although the gauze was heated to a dull red. With the inflammable mixture moving at the rate of 2 ft. per second experiments were made for twenty minutes with a like result. Generally, as to the results of these experiments, Mr. Hilton says that "this accident requires it to be shown whether this type of lamp is safe in a still, inflammable atmosphere." Mr. Gerrard also says "that in his opinion the Clanny lamp is not one of the best types of safety lamp, and moreover, that the cause of No. 3's lamp failing was not from any injury to any of its parts, but that it was the 'principle' of the lamp, and that this accident emphasizes the importance of thoroughly testing whether the lamp is safe before permitting its use in fiery mines. Unfortunately so-called safety lamps were introduced without such a complete test as was, in his opinion, necessary. To go to a lampmaker's shop one sees all sorts and sizes of lamps, gauzes, and glasses. Although unshielded lamps are practically prohibited by the Act they are still used, it being almost impossible to obtain a conviction before the magistrates for such an offense. Mr. Gerrard further says that he hopes that the lesson taught by the Shakerley explosion will lead to such consideration and full recognition on the part of all connected with fiery mines, firstly, not to advance at all in an inflammable or explosive mixture with even a securely protected safety lamp, and so risk bringing on an explosion."

Bonneted Clanny lamps from Allerton Main, similar in construction to the one experimented on by Mr. Hilton were experimented on by Professor Lupton, of the Yorkshire College, Leeds, with explosive mixtures of air and lighting gas moving at various velocities, and forced on to the lamps by a fan, but no failure was recorded until a velocity of 50 feet per second was obtained. This velocity was calculated from the reading of a water gauge placed between the fan and the lamp, and was not confirmed by an anemometer test. As in the Shakerley tests, dust was not included in the experimental atmosphere, and therefore the only information obtained was, that a certain make of bonneted Clanny lamp would stand exposure to certain conditions for a certain length of time without failure. The conditions under which the tests were made were not materially different from those adopted by the Mines Accidents Commission, when testing the very first lamps of the present bonneted type which were designed and submitted to the Commission by the writer on the 9th of May, 1882, and known in the Official Report as Nos. 17, 18, and 19, Clanny's. Nos. 17 and 18 were almost exactly the same in construction as the Shakerley lamp, only that the latter had a copper instead of an iron gauze, and were tested up to a velocity of 1,926 feet per minute for 38 seconds, and to 1,500 feet per minute for 94 seconds without failure, and No. 19 (Fig. 21 of the M. A. C. Report) which had a different pattern of shield or bonnet was only exploded with a velocity of 2,857 feet per minute after an exposure of 32 seconds. Now, although Nos. 18 and 19 were tested so long ago as August 4th, 1882, the writer does not consider that this represents their safety value excepting on paper, although as such it may be considered as comparatively very satisfactory. Just to show there are conditions not thoroughly understood which affect the safety lamp, another of his safety lamps may be referred to, viz., the Ashworth No. 6 of the same report. This lamp was double bonneted and of the Mueseler-Arnould type. It was tested to 2,897 feet per minute, without failure, and a similar lamp was tested by Mr. Rhodes many times, also without failure, until one day when experiments were being made for some visitors, failure occurred, and it is doubtless a fact that the conditions were such that a larger percentage of gas than usual entered the lamp, passed up the chimney, and fired the mixture with which the outer cylindrical gauze of small diameter and cubic contents was doubtless filled, and originated a very severe explosion in the apparatus. Knowing these facts, and also that during the course of experi-

ments made by the writer in 1879, he had discovered that if a Davy lamp were exposed to a current of air containing only 4½ per cent. of firedamp and only as much of 8 feet Bambury coal dust as a velocity of 370 feet per second would lick up off the floor of the testing gallery, and carry in suspension, it would allow the flame to pass through the gauze and explode the outer atmosphere in from 7 to 11 seconds without heating the gauze above a cherry-red. With a similar percentage of firedamp and velocity, but with the coal dust eliminated, the Davy lamp could not be exploded. It is a most unfortunate circumstance that neither the Mines Accident Commission nor yet the Commission on Explosions from Coal Dust ever touched on the influence of dust on safety lamps, but its importance may be realized when we consider that the particles of coal or other dust always floating along in the air current of a coal mine, are so small that they pass through the gauze mesh without trouble, and if from any cause gas is burning within the gauze, or the gauze is in addition red hot, we do not require any great stretch of imagination to estimate what may result from such a combination. The writer does not think that people in general understand what is the most dangerous condition to which a safety lamp may be exposed in the everyday life of a coal mine, and therefore he may say that it is when a lamp is suddenly raised into an atmosphere of firedamp containing very little air, or when a ventilative current containing an excess of firedamp suddenly surrounds a lamp, or approaching as a down current suddenly fills the lamp from the top and crushes down the wick flame. Such a state of risk, especially if aided by a little suspended coal dust, is fatal to all lamps which admit of a reverse current being formed within the lamp. The Stephenson lamp is especially subject to this danger because the air supply below the glass is insufficient to feed the wick flame and to prevent a down current from the top of the lamp. Likewise this danger is brought before us very forcibly, by the explosion supposed to have originated from the use of self-igniters in a Wolf lamp, which is confirmed by the tests made by Bergrath Mayer and Bergassessor Balzer, and also by the tests made by M. Marsaut on lamps filled with an explosive mixture and fired at about the same level as the wick flame by an electric spark. M. Marsaut made 108 trials on his double gauze lamp, 92 without the shield and 16 with that appendage, and he obtained 12 exterior explosions or 1 in 9, and only his three gauze type resisted a total of 201 tests. These tests of M. Marsaut point out very clearly indeed that safety lamps, particularly those which are used by officials such as managers, deputies, firemen, and timbermen ought to be provided with a much safer mode of bonneting, viz., one which will absolutely preserve the lamp from becoming filled with an explosive mixture from the top.

This contribution to an important subject which concerns the everyday life of a coal mine might be still further extended, but the writer thinks that he has provided sufficient subject matter for very careful consideration.

Waterproof Blueprints.

Written for MINES AND MINERALS, by A. B. Jessup.

Those who have experienced the annoyance of having blueprints discolored and blurred by rain, droppers in mines, and moisture in general, will appreciate a simple and inexpensive method of waterproofing the prints which renders them completely impervious to weather and water. The waterproofing medium is refined paraffin, and may be applied by immersing the print in the melted wax, or more conveniently as follows: Immerse in melted paraffin until saturated a number of pieces of an absorbent cloth a foot or more square, and when withdrawn and cooled they are ready for use at any time. To apply to a blueprint, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second waxed cloth on top and iron with a moderately hot flat-iron. The paper immediately absorbs paraffin until saturated and becomes translucent and highly waterproof. The lines of the print are intensified by the process and there is no shrinking or distortion. As the wax is withdrawn from the cloths more can be added by melting small pieces directly under the hot iron. By immersing the print in a bath of melted paraffin the process is hastened, but the ironing is necessary to remove the surplus wax from the surface, unless the paper is to be directly exposed to the weather and not to be handled. The irons can be heated in most offices by gas or over a lamp, and a supply of saturated cloths obviates the necessity of the bath.

This process, which was originally applied to blueprints to be carried by the engineer corps in wet mines, is equally applicable to any kind of paper, and is convenient for waterproofing type-written or other notices to be posted up and exposed to the weather.

THE ARRAGON MINE

At Norway, Michigan—A Description of the Mine, the Machinery Used, and Manner of Working.

Written for MINES AND MINERALS, by E. S. Dickenson.

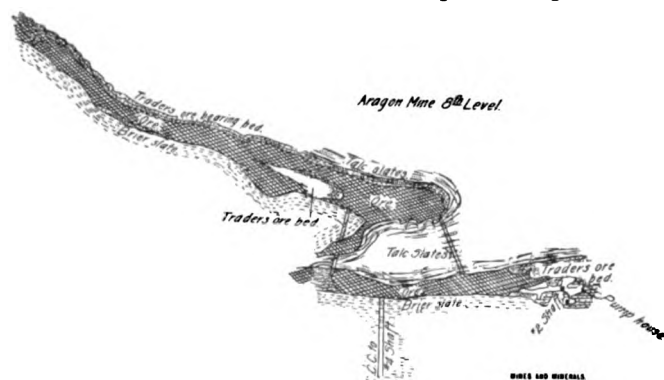
The Aragon Mine is one of the three largest mines on the Menominee Iron Range, its shipments in 1899 amounting to 337,807 tons, and in 1900 to 362,596 tons.

The mine is located in the city of Norway, some of the workings extending under the business part of the city. It lies in an old swamp which is surrounded by bluffs of dolomite.

The shafts which have thus far been sunk on this property have penetrated a layer of muck and quicksand, which has given a great deal of trouble. Some good examples of drop shafts may be seen here. No. 1 and No. 3 shafts have been abandoned and are now closed in, due to the swelling ground.

Ore was discovered here by a diamond drill, and Mr. Frank Janson, mining engineer for the Penn Iron Co., is probably the one to whom belongs the honor of discovery. From his study of the geology of this district he believed that there was ore at this point. He interested others, and it was decided to put down a drill hole. Mr. Janson showed them where to drill and ore was struck in the first hole. The ore body which was found has steadily increased in size with depth. The geology of this district is fully described by Professors Van Hise and Bayley in their report.

The surface plant at this mine is quite complete. All the shops, boiler and engine houses, etc. are covered with galvanized iron. The shops are all located in one building. In the carpenter shop, which is 40 ft. $\times$ 36 ft., there is a band saw, circular saw, and a lathe. In connection with the carpenter shop there is a



PLAN OF ARRAGON MINE.

small sawmill for sawing timber and lumber. Framing is all done by hand. The blacksmith shop is 45 ft. $\times$ 36 ft. It contains a 600-pound steam hammer, with 21-inch stroke, and also a punch with shearing attachment. The steel cars which are used in the mine are made here.

The machine shop is 50 ft. $\times$ 36 ft. with boiler room attached in an addition. This shop contains three lathes, a drill press, planer, bolt cutter, and pipe machine. The engine which runs the three shops and the sawmill is located here. It is an Allis Corliss engine with cylinders 10 in. $\times$ 30 in., running at 90 revolutions per minute.

The boiler room contains a tubular boiler and a feedwater heater; this boiler is idle at present as steam is taken from No. 2 boiler house.

The chemical laboratory and engineer's office are in a small building at the end of the shops. New quarters will soon be available as the present quarters are too small. The laboratory is fitted out very completely for the analysis of iron ores. Samples are taken from the mine every day, every place in the mine being sampled every second day, or at most every third day. Samples are also taken of every train load taken from the mine. The average number of analyses made for iron and phosphorus for the present season has been 18.3 per day.

The engineer's office contains complete maps of the mine, also of other mines owned by this company. The maps are kept up to date and never allowed to fall very far behind the new work. The maps consist of plans, cross-sections, longitudinal sections geological maps, and chemical maps. Upon the chemical maps are placed the percentage of iron and phosphorus for every square set. These are very useful in mixing the ore, as they show about how the adjacent ore may be expected to run.

No. 2 boiler house, 83 ft. $\times$ 28 ft., contains two 100 H. P. firebox boilers 24 feet long 6 feet in diameter, each being fitted

with two pop safety valves, and three tubular boilers 18 feet long, 66 inches in diameter rated at 90 H. P. each.

This building also contains a feedwater heater, a 500 H. P. Hoppes purifier and feed pumps.

No. 2 engine house, 34 ft. $\times$ 34 ft., contains a Webster, Camp, and Lane duplex first-motion Corliss hoisting engine, with a 6-foot split drum. The width of the face of one section of the drum is 20 inches, while the other is 7 feet 5 inches. When hoisting in balance these sections are clamped together by a clutch worked by a hydraulic ram; and as one rope winds up the other rope unwinds. When it is desired to hoist from a different level, the cage fastened to the small section of the drum is lowered, then the sections are unclamped and the other cage either hoisted or lowered until proper adjustment has been obtained; then the sections are clamped together and the cages are used in balance as before. The operation takes only a minute or two. This split drum is very convenient and works well, except that it wears the rope where the rope comes in contact with the split in the drum. The capacity of this hoist is 10,000 lb. at 1,500 feet per minute. The engine reverses by link motion. The cylinders are fitted with automatic relief valves, which relieve any excess pressure, caused by water gathering in the cylinders.

Next to the No. 2 engine house is a small building which contains No. 2 rope-haulage plant, used to take the ore from the shaft to stock piles. During the winter the lake transportation is stopped due to ice, and as all-rail transportation costs too much, the Lake Superior iron mines stock their ore in large stock piles on the surface; in the summer these are loaded by steam shovels into cars and transported to the lakes, where it is loaded onto the vessels.

The mine car, as it comes to the surface, is run into a cradle and dumped into a stock pile car; this car is run out on a trestle and automatically dumped, and then it is brought back by a tail rope. These cars dump in different places depending on the grade of ore they contain.

There are two cars and two sets of drums, and two drums in each set. The drums are worked by the same engine; any one, or one drum from each set, may be attached to the engine by friction clutches.

When a car is to go out, one drum of that set is attached to the engine; when it is to come back, the other drum is attached.

No. 4 boiler house contains three 285 H. P. Babcock and Wilcox water-tube boilers, built to carry 160 lb.; a Webster vacuum feedwater heater of 1,000 H. P. capacity; a 1,000 H. P. Hoppes purifier, first used April 24, 1900.

These purifiers have been found to work very well indeed. The feedwater contains large quantities of lime and scale-forming material which these purifiers remove. The purifiers are cleaned about once a month. The boilers have been free from scale since the purifier was put into use.

No. 4 engine house, 75 ft. $\times$ 34 ft., contains a hoisting plant similar to the one in No. 2 engine house; a Ball engine, cylinder 8 in. $\times$ 10 in., running at 320 revolutions per minute, which drives a brush 20-light arc dynamo which lights the surface and buildings. A compound, condensing, two-stage Norwalk compressor is also contained in this building, as well as a three-stage compressor. The large compressor runs the air drills, pumps, etc. underground as well as ventilating the workings and supplying the blacksmith shop with air. The air pressure is about 75 lb. The little three-stage compressor is used for the underground pneumatic locomotives and compresses air to 800 lb. pressure. This compressor has two governors, one to regulate the air pressure and one to act, if by sudden relief of pressure the compressor would race.

A Vulcan steam shovel is used for loading the stock pile and a Bullock diamond drill for exploring.

At No. 4 shaft is seen the first steel headframe on this range; skips are used in this shaft and they are fitted with safety clutches and detachable hooks.

A haulage plant similar to the one at No. 2 shaft is working at this shaft. This is a three-compartment vertical shaft which passes through the south or Curry member of the Vulcan formation. It does not pass through any ore, however. At the first level a drift and crosscut has been driven and an effort made to catch the surface water here, instead of letting it into the workings. The next level in this shaft is the 8th level, where the main pump is located. This pump is a triple-expansion, duplex, Worthington pump; capacity, 1,200 gallons per minute at 1,200 feet lift.

The ore is brought to the shaft through a large crosscut to the workings by a pneumatic locomotive in 1-ton cars, which are run into cradles and dumped into the skips. The locomotive was manufactured by H. K. Porter & Co.; it is a class P. R.; cylinders 7 in. $\times$ 12 in.; 22½-inch gauge. A winze will be sunk to the 10th level, and this shaft will be raised from the 10th level to the 8th level.

The No. 2 shaft is a three compartment vertical shaft, provided with a wooden headframe. Cages are used in this shaft instead of skips, and they have the same safety appliances as the skips at No. 4 shaft. This shaft is used for lowering timber, and for lowering and hoisting men, as well as for hoisting ore. The shaft is down to the 9th level, and is at the east end of the ore body, which lies in a pitching trough of the Traders member of the Vulcan formation.

The formation is folded at this point, and the ore lies in the fold as well as in both arms of the fold. One arm of the fold extends east and the other west. The foot wall is a talc slate changing into a dolomite as it gets away from the ore-bearing member. The hanging wall is soft silicious slate, named by Prof. Bayley, Brier slates. The dip is south and the pitch is toward the west.

The mine used to be worked on the rooming and filling method, the filling used being sand, which occurs in large quantities just north of the mine, and which was sent down a chute into the mine.

The mine is now worked by the caving system, except near the shaft, where the filling system is still in use, rock filling being used, however, instead of sand.

Main levels are driven 100 feet apart, on the 8th level crosscuts were driven every 35 feet, but upon the 9th level this distance will be increased.

Raises are put up from these crosscuts. In places the raises are put up from the drifts and no crosscuts are driven. Sublevels are driven, between the main levels, 25 feet apart. Drifts and crosscuts are driven to open up the ore, and then in the end of these the ore is allowed to cave in as fast as it is removed. If the ground does not cave properly, blasting is resorted to, or a larger extent of ground is opened up, so that it will cave more readily. At times it is necessary to drive subs between the sublevel.

When all the ore is taken from one cave and the rock has come down, another set of timber is removed and a new cave started, always retreating toward a winze. The pillars are worked in the same way. There is left a small piece of ground between



VERTICAL SECTION, ARRAGON MINE.

the drifts and crosscuts which were first driven and those which were driven through the pillars, but this ground is taken out when the next sub below is caved.

The ore from a cave is trammed to a raise which has been turned into a chute and ladder road. These chutes carry the ore to the main level where it is loaded into cars and taken to the shaft.

After one sublevel has been worked out in a body of ore, the next lower sublevel is worked. After all the subs above a main level have been worked out the main level is worked in the same manner.

The tramping on the sublevels is done by men; on the main levels the men pick up the cars for the mules, which in turn pick them up for the locomotives, which take the cars to the shaft.

At No. 2 shaft on the 8th level there is a Worthington triple-expansion, duplex pump; 750 gallons capacity at 1,000 feet lift. This pump is a reserve pump used when the pump at No. 4 shaft is being packed or repaired. There is also a Worthington compound duplex pump here.

No ore is hoisted from this level through this shaft. This is to avoid the trouble and danger of gates, and loading ore from two levels in a shaft where men go up and down.

Back from this shaft on this level is located the powder and oil house and farther back is a blacksmith shop where drills are sharpened.

Ten mules are used for collecting the cars on this level, and their barn is located in Brier slates off of the crosscut to No. 4 shaft. It is large, airy, and dry, and is ventilated generally by compressed air; but can also be ventilated by a fan which takes its supply of air from the shaft. This fan is run by a waterwheel which takes its power from the water column in the shaft.

On the 9th level 2-ton cars are used instead of 1-ton cars as on the 8th level. The drifts are being driven larger and with easier curves to accommodate the pneumatic locomotives.

An H. K. Porter pneumatic locomotive, "Merrian," with cylinders 7 in. $\times$ 12 in., and similar to "Sarita," which is used on the 8th level, is used to bring the cars to the shaft. The loaded cars are run onto the cages from one side of the shaft and the empties are taken off from the opposite side, where they are run into a separate drift, where the locomotive picks them up. This gives more room than if the empties were taken off on the same side as the cars were put on from, and gives an increase of speed and less danger of accident.

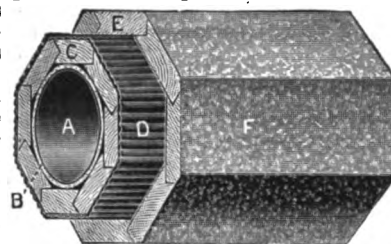
This level is being rapidly opened up and a crosscut is being driven to meet No. 4 shaft at the rate of 4 feet a day.

The mine is owned by the Commonwealth Iron Co. O. C. Davidson is superintendent; H. F. Ellard, assistant superintendent; G. A. Hillberg, mining engineer.

Wyckoff Patent Covering for Steam Pipes.

The illustration shows a sectional view of the patent steam pipe covering for insulating underground and exposed steam or hot water pipes, manufactured by the A. Wyckoff & Son Co.

It consists of two layers of non-conducting wood which are held together closely by steel wire, being separated by two layers of heavy non-conducting paper. A thin layer of air comes in between each layer of wood and paper which adds greatly to the insulating qualities of the covering. Results of actual tests have shown the Wyckoff covering to be the most perfect insulator used for underground work, as well as a thorough protection for the pipes. It is made of white pine which is carefully selected and free from all sap to insure its greater durability. The A. Wyckoff & Son Co. furnish their coverings in two styles; the unlined for low pressure steam and hot water pipes, and the tin and asbestos lined for covering high pressure steam pipes.



Where the tin and asbestos lined covering is used no matter how high the steam pressure no other wrapping or covering for the steam pipes is necessary.

The manufacturers have supplied this style of covering extensively to the leading steam users, and it has given such excellent results that they are not alone using it on the long lines of underground pipes but on their small jobs as well, where the lengths are short. It is also largely used in central steam and hot water heating plants for insulating the underground pipes. The loss of heat in ground radiation which is usually so large an item in a system of this kind is by the use of the Wyckoff covering reduced to a minimum, the water being returned with but a very few degrees loss in heat.

Metallic Paint.

Metallic paint is obtained by grinding certain qualities of hematite iron ore. Some of the ores are roasted before grinding in order to improve their color and durability. Considering the profusion of iron ore which exists in the United States, the amount of material suitable for making a good quality of metallic paint is small and the localities comparatively rare. Among the localities from which good paint ore is to be obtained are Oneida, Rensselaer, Cattaraugus, and Washington counties, New York; Lehigh, Carbon, and Mercer counties, Pennsylvania; Hamilton and James counties, Tennessee, and Dodge county, Wisconsin. It is also produced in smaller quantities in Maryland, Arkansas, California, Illinois, Iowa, Vermont, Missouri, Ohio, and Wyoming. Part of the ore ground for paint is used as a coloring matter in mortar making. It is not always possible to separate exactly the amount used for mortar colors, as the manufacturers, having sold it as dry ground paint, do not always know how it is consumed after leaving their hands. The separation given in this report is the best that could be made. It is not claimed that it is absolutely correct.

The production of metallic paint in 1899 (exclusive of mortar colors) amounted to 23,423 short tons, valued at \$249,945. As compared with 1898 this shows an increase of 2,451 short tons in quantity and a loss of \$14,034 in value. While there was probably a slight falling off in values in 1899 the large decrease in value, when accompanied by such a substantial increase in product, is more to be attributed to an increased production of cheaper paint and a falling off in the output of high-priced grades.

The production of mortar colors decreased from 7,107 short tons in 1898 to 5,736 tons in 1899. The value fell off from \$74,864 to \$65,156.—U. S. Geological Survey.

The Relations of Capital and Labor.

By HERMAN JUSTI, Commissioner Illinois Coal Operators' Association.*

The great Prince of Peace, at the mention of whose name every head should bow and every knee bend is credited with having said to the Jews which believed on him, "If ye continue in my word, then are ye my disciples, and ye shall know the truth and the truth shall make you free."

On this glad day set apart by the representatives of a free government, in order that American toilers might appropriately commemorate whatever advance they have made in the direction of higher standards of living and higher ideals of citizenship, we should ponder well the assurances of the Saviour: "If ye continue in my word, ye shall know the truth, and the truth shall make you free." On this happy occasion, my fellow citizens, I desire to apply these divine words to the relations that you and all of us bear to the true spirit of unionism. I desire also, with genuine pride as an American citizen, to rejoice with you in whatever advance has been made as the result of organized labor, and, under the changed conditions, to point out, without offense, our duties and our dangers. The representatives of American capital can ask no greater boon than the fulfillment of the hopes and promises of the founders of unionism, viz., the advancement of the toiling masses to higher standards of living and to higher conceptions of citizenship. By keeping your eye firmly fixed on these high and worthy aims of true unionism; by bending every noble energy to attain them, you will prove yourselves true unionists: you will show yourselves to be true American patriots; you will know the truth indeed and the truth will make you free. And unless you attain to these high aims your progress in organization will have been made in vain; the highest possible scale of wages will do you no good, and the eight-hour law will prove to be a curse instead of a blessing. For assuredly if higher wages do not mean greater comforts and opportunities for your wives and children; if the added hours of leisure are not used wisely, it were better that your wages had remained low and your hours of leisure were reduced. These may not be pleasant truths to some of you, but I believe there are tens of thousands of high-minded laborers and hundreds of thousands of good women and promising children who will thank me for having spoken them.

I should be unworthy to stand here as a representative of the capital class; I should show scant courtesy to your committee who have invited me to speak on the relations of capital and labor, did I not weigh well my every utterance and speak the truth at this time as I would speak it if this moment was my last. I might tell you only pleasant things and so for the time being please you and win your applause, but in the end I should thus injure you and the cause you have at heart, and so deserve your contempt. You know full well that the man who would use the present occasion to tell you that the laborer is always right and his employer is always wrong, is not your friend. He is rather a mischief maker and a self-seeking demagogue who feeds and grows fat upon human strife and the consequent misfortunes of his fellows. Equally to be despised are they who ignore the rights of the toiling masses, or who, having ears, hear not; having eyes, see not. As for those timid representatives of capital, they who see in trades unionism a roaring lion at the end of every lane, I would not worry about them. They are not hostile to you, but simply over-conservative, and so they are slow to adopt new ideas. Rely upon reason and example to win them over to these modern ideas, for as you well know every reform is attended alike with difficulties and with mistakes, and the reform inaugurated by the champions of the cause of labor is no exception to the common rule. They can see no excuse for or justice in violence, which unfortunately has been too common, and as all reforms founded upon and prosecuted in a spirit of kindness, fairness and love have survived and their principles are eternal, so, too, your reform must have as its foundation stones justice and right if the gulf that yawns between capital and labor is to be forever closed, and universal recognition is to be given to true unionism. There are two cardinal truths which I desire to impress upon the representatives of both capital and labor, and which, if kept in mind, will make their reconciliation easy. These are:

1st. That capital legitimately employed is entitled to the protection of the laborer and to the protection of the law.

2nd. That labor honestly performed is entitled to its full reward, and that the conditions surrounding the laborer and his family shall be consistent with the demands of modern civilization.

From these truths what conclusion is to be drawn, and these truths being admitted what is our duty in the premises? Certainly the conclusion to be drawn is, that capital and labor are

mutually dependent, and that therefore each owes to the other a solemn duty. This duty is embodied in the two cardinal truths I have just endeavored to enunciate, imposing at the same time upon both the still higher duty of preserving at all hazards peace and order, and of enforcing observance of the laws and respect for the constituted authority of our land. But if it happen that either capital or labor have a grievance growing out of the insufficiency or inadequacy of our laws then change those laws in the manner prescribed by the constitution of the state or nation, and not otherwise. Rest assured that no cause can triumph on American soil, be it the cause of consolidated capital or of organized labor, if that cause is in any sense opposed to the spirit of free institutions, and even if that cause seem ever so worthy, public sympathy will be withdrawn, if to achieve it we ignore the examples of our Fathers, or depart from the principles for which they struggled in the infancy of the republic. Thank God, no cause can long survive in this free land unless it have public sympathy and public opinion on its side, and depend upon it also, that no question is ever settled until it is settled rightly. Consolidated capital by reason of greater wealth, or organized labor because of superior numbers may triumph for a season, but it is only a question of a little time until old wounds shall bleed afresh and capital and labor shall become more estranged than ever, unless their differences are settled by a standard that no fair man can dispute.

On this day, therefore, set apart in the interest and in honor of organized labor, I feel we should be honest in our praise and fair in our criticism of the interests, which in a sense, we respectively and at the same time jointly represent. It is the proper time for capital and labor to realize that the great labor problem is the problem of our times; that it is the problem that affects us as does no other one before the American people; that it is the one problem we shall have with us always, or at least until it is rightly solved and until the true relations of capital and labor are fully established and universally recognized. I congratulate organized labor upon its part thus far in solving it, and upon its marvelous growth, and in wishing it ever increasing prosperity, let me warn you that it needs something more than numbers and power. Your organization is already powerful, but something besides numbers and organization is necessary. You need discipline, and underlying discipline high character is imperatively demanded. Above all else wise leadership is necessary and you can't all lead, nor can you all tell exactly how you shall be lead. Choose, then, as your officials, as your leaders, your best men; trust them, heed their counsel, make them strong and wise by following them with confidence and submission, and your success is assured. In no other way is it possible. In no other way can you bring out the qualities of leadership. Officials who go around with their ear to the ground—as do some public men in America—are only demagogues; they are only time servers; they are advocates of the cause of labor for revenue only, or for office only.

No, my fellow citizens, it is not numbers, nor organization, nor power that will make you truly strong, or great, or make your triumph sure. It is character; it is the lives you lead; it is fidelity to your wives, and duty nobly done in behalf of your children, that will tell in the long run, and will achieve everything you can reasonably desire. Let your individual example of sobriety, industry and thrift, your comfortable homes and happy families, be so striking in their superiority that every toiler now without the fold will seek admission to your union. You have then only to open your ranks and they will come in. Thus they will be doing what you desire of them; labor will then be united indeed; reverence for things sacred will be re-established; authority will be recognized, the laws obeyed, and peace and plenty secured for all who labor, whether that labor be of the hand or of the brain. Then, too, let me confidently assure you, that employers of labor everywhere will not only approve of the union, but they will gladly urge their employes to enter it, and more than this, organized capital everywhere will be happy to recognize organized labor and treat with it on terms of equality and fairness.

When, then, we arrive at this advanced stage of civilization, which I am optimist enough to fondly believe is not far distant, we shall never hear of strikes, and only occasionally will there be need for arbitration, all differences and disputes being settled in a practical, common sense and manly way, viz., by conciliation. Indulge me while I give briefly my ideas of the different methods of settling disputes between employer and employe.

To try to compel settlement by a strike is simply to test the power of intimidation and force on the one hand, against money and endurance on the other, and in the conflict of the two it is always might that triumphs, and while it is not claimed that right is not sometimes, or often even, on the side of might it is only because the two are united that justice prevails.

Settlement by arbitration is, in the main, a compromise of

* An address delivered under the auspices of the Federation of Labor on Labor Day, September 3d, 1900, at Springfield, Illinois.

interests, each party reluctantly yielding something to re-establish peaceful relations, at the same time often securing only half justice to either party to the contest.

Settlement by conciliation is the commonsense application of the golden rule to differences or disputes arising between employer and employe, and differences or disputes so settled are founded upon what each side finally concedes to be right.

Some of you no doubt know, and to those who do not know it, I rejoice to tell it, that the United Mine workers of Illinois and the Illinois Coal Operators' Association, have resolved to adopt the commonsense, manly plan of adjusting all differences between coal operators and coal miners, of taking them up and considering them in a spirit of fairness, and of adjusting them upon their merits solely, and if their success of the past three months continues in the future we shall hear no more of angry strikes in the state of Illinois.

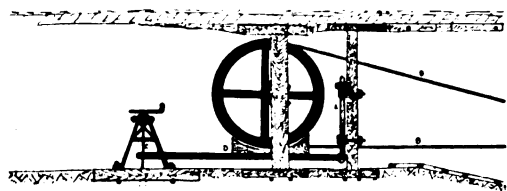
I rejoice to tell you that this movement has been met by all classes everywhere with favor and it has received their hearty approval. Is it too much to expect, or at least to hope, that the same sensible plan will be universally adopted, thus uniting capital and labor for the wise and happy ends designed by the Creator?

But why not give to this movement the approval and support of every citizen? Does it not deserve it? Was it not conceived in a spirit of justice and fairness? Was it not born of the necessities of our times? Can it mean anything else than that we are resolved to render unto capital what is capital's and unto labor what is labor's? By this plan do we not insure protection and profit to the one, and employment and fair wages to the other? Does it not restore peace where there was discord? Does it not encourage and exact fair dealing among men? Does it not give to organized labor the recognition it asks and to capital the consideration it deserves? Who, then, will have the temerity to oppose a movement designed for your advancement, and for ours, to higher standards of living and to higher ideals of citizenship?

For one, my heart is in this work, and I fondly believe it has the support of the wisest leaders of labor and the fairest representatives of capital in free America. Together let us all labor for a cause, which, if it succeeds, and succeed it must, will contribute to the realization of our highest hopes and add honor and glory to the American name. Then, indeed, we shall realize the full meaning of those sublime words, "If ye continue in my word, ye shall know the truth, and the truth shall make you free."

A Jig Wheel and Brake.

Mr. John Fox, of Norton Canes, near Cannock, Staffordshire, writes as follows: During the last twenty years many great improvements have been made in almost all branches of mining, but I think that in one particular a further improvement could be made—viz., in the present methods adopted for lowering cars or trains of cars down steep inclines. By the old method a jig wheel and handle is used, but many serious accidents occur owing to the handle striking the workman from some unexplained cause. Being well acquainted with jigs I have adopted the plan



as shown by the accompanying sketch. This jig wheel and brake will ensure a good train of cars being let down the steepest incline with the greatest ease and safety and entirely under the control of the person working the jig. The brake consists of a lever and screw working through two screw blocks, one block just below the handle and the other end of the screw passing through a block which is centered in the end of the brake lever. The wear of the brake can be taken up at each end of the levers. At the front of the wheel the tension can be taken up by screwing up the nut. The screw that actuates the brake can also be used to take any wear that may occur from time to time. It will be seen from the sketch that the screw acts in a twofold manner, and the train can be brought to rest in the shortest time possible if required. The power of this brake will be seen from the following formula:

$$\begin{aligned} \text{Lever} &= 8 \text{ ft.} \\ \text{Power applied by person} &= 90 \text{ lb.} \\ \text{Constant} &= 6\frac{1}{2} \\ \text{Screw} &= \frac{1}{4} \text{ in.} \\ 96 \times 6\frac{1}{2} \times 90 &= 12 \text{ tons.} \end{aligned}$$

In the sketch *A* is the tightening screw, *B* the jig rope, *C* the screw, and *D* the lever block.—*Colliery Guardian*.

The Burning Mine at Summit Hill.*

Written for MINES AND MINERALS.

Two years have elapsed since the writer's previous visit to the burning mines of Summit Hill, Pa. The residents of that town, though, can still claim the burning mines as their chief point of interest; while the evidence of heat in the underlying coal is more prominent than two years ago.

Increased activity is displayed on the part of the property owners in combating the fire, while the fire itself seems to be making desperate efforts to get beyond the barrier that is gradually hemming it in. From the line of drill holes at present being drilled the fire has evidently gotten around or beyond the barrier of two years ago. The rapidity with which it travels is remarkable. Gangways driven in the old workings toward the fire are found to be themselves on fire when no signs indicated its presence. The shutting off of the air currents by the barriers of culm washed in causes the fire to be seemingly endowed with intelligence in the manner in which it searches out new passages and the remarkable rapidity in which it takes advantage of all openings. From the gradual shutting off of its air supply, drawn mainly through the old workings, the fire in some places is being forced upward toward the surface, making use of the cracks and crevices in the rock to get air. Especially in one locality is this evident, in a space probably 300 feet square. Here the surface has a baked appearance. All vegetation is dead. The atmosphere has that blue, hazy appearance indicative of a fire, while the tremulous or wavy appearance of the air shows its heated condition. The fumes of sulphur together with the heat make it impossible to stay any time in the locality. The surface is seamed with cracks. In the daytime they emit puffs of pale colored smoke, while their edges and the ground in the vicinity is covered with a white deposition of sulphur. At night hundreds of small blue flames are seen playing over the surface with here and there a large one. The rock in many places glows with a dull red to a white heat. While at first thought the evidence of fire so near the surface would seem to indicate increased activity for the fire or a gain on its part, it is practically a victory for the culm and water used in putting it out. They have turned what may be called the right flank of the fire back on itself and in its fight for air it has been forced to the surface.

Active preparations were being made during the fall months to continue the fighting of the fire during the winter. Formerly this was not done. The long lines of troughs necessary to conduct the water and culm to the various holes would freeze up during the winter months and in consequence all operations stopped until spring. Thus the fire had a chance to partially regain during these three or four months of enforced idleness what it lost during the summer campaign. Half a mile of new siding has been built and a pocket erected in closer proximity to the holes lately drilled. This will do away with probably over a mile of troughing, which was becoming exceedingly unwieldy. The holes being drilled farther and farther away made it extremely difficult to give some of the troughs the necessary pitch to carry the culm. Some of these troughs or flumes were 60 feet above the surface.

To overcome the freezing difficulty the operators propose to heat the water, necessitating a change in the pumping system. Formerly the water was pumped direct from No. 9 Tunnel mouth to the pocket where it was mixed with the culm. Now a secondary pumping station has been established, and the water will be pumped to practically the same elevation as before, but not quite the same distance. A small local basin on the north edge of the Summit Hill anticlinal is to be made use of as a reservoir. This is also in close proximity to where the new pocket is built and here is where the second pump is located. A system of boilers or tanks is to be erected to heat the water. The culm used in the future will be taken from an old breaker dam erected about half a mile below the Nesquehoning breaker and on a small tributary that flows into the Lehigh River above Mauch Chunk. This dam is full and a new dam is being erected to catch the breaker water during the emptying of the old one. What system would be employed in emptying the dam had at that time not been fully decided on. Probably some overhead cable and conveying device.

A peculiar feature of this mine fire is that it will often burn the slate partings between the benches of coal and not touch the coal. In numerous places the slate will be burnt from a dark red to a white color and often to ashes, and the coal on either side not touched. Slate often possesses as high a percentage of carbon as the coal and probably the reason that the fire shows a preference for the slate in some localities is that it may be more open or more seams and cracks in it than in the coal. The latter being more dense would prevent the admission of air which the more open formation of the slate would admit.

*A description of the methods being employed to extinguish the fire in the mine will be found in MINES AND MINERALS for May, 1899.

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PRACTICAL MINING STUDIES.

WE WISH to call especial attention to the department headed Practical Mining Studies which begins with the present issue of MINES AND MINERALS, and which will, we feel sure, appeal to all classes of mining men.

While these studies will be simple and elementary they may or may not be "easy," dependent entirely upon the subject under treatment. Some subjects are comparatively simple; others are necessarily difficult; but every effort will be made to simplify the difficult problems as greatly as possible and to make the rough places smooth.

For a number of years past MINES AND MINERALS has been the only technical journal to publish answers to the questions given in the examinations for mine officials in the several States. Until comparatively recently the number of States requiring such examinations was small and it was possible to answer all the questions asked through the columns of MINES AND MINERALS. The number of States in which such an educational test is required before the person is permitted to assume a position of trust is increasing yearly and at the present time the number of examinations held each year is so large that it is impossible for any periodical to answer all of the questions given. Moreover in many States there is a movement on foot to follow the example of those States which have found these technical qualifications to be of so much benefit to the mining industry, and scarcely a winter passes but that some State Legislature provides that candidates for official positions in its mines must present themselves for examination and secure a certificate of competency. As a result of this tendency to require mine officials to secure such certificates there is a large body of ambitious miners in districts where requirements have already been adopted and also in other sections where similar requirements will probably be adopted in the near future, who wish to prepare themselves so that they can secure the coveted certificate of competency which will render them eligible to appointment to a position of responsibility.

For years past MINES AND MINERALS has conducted a department which in addition to answering as many as possible of the questions asked in the several State examinations has included short articles which have enlarged upon the points brought out by the examination.

Since so many questions are given each year in different sections of the country upon the same general topics, and particularly since these same topics have been treated in the examinations for a number of years past, there must of necessity come a time when it is almost impossible to prepare an entirely new set of questions, and when any one having a file of MINES AND MINERALS can by referring to the back numbers of this journal find an answer which will, substantially at least, answer any question likely to be asked in a mine examination. For this reason and on account of the constantly increasing number of inquiries which we receive asking for an explanation of the principles underlying the science and theory of mining, the articles under Practical Mining Studies will be devoted more particularly to the presentation and explanation of these underlying principles, using the questions given in the current examinations to illustrate the general principles. In this way a reader of Practical Mining Studies will be provided with material by which he can solve any problem that is likely to be presented to him in his daily practice or which is apt to be included in any mining examination which he may wish to take.

In a general way we may divide the subjects to be treated under the following heads: 1st, Mathematics and Surveying; 2d, Mineralogy, Lithology, Geology, and Prospecting; 3d, Assaying and Metallurgy; 4th, Mining Machinery; 5th, Methods of Working Mines; 6th, Timbering; 7th, Ventilation of Mines; 8th, The Application of Electricity to Mining Problems; 9th, The Preparation, Washing, and Concentration of Ores and Coal.

It will of course not be practicable to treat all of these topics in every issue of MINES AND MINERALS, and while there will be a

certain continuity of treatment, each article will, whenever possible, be complete in itself, and will deal with some distinct phase of the subject treated. Nor does this list of topics necessarily include all of the subjects which will be considered, but as other subjects are suggested from time to time, or whenever other subjects seem to be particularly pertinent, they will be taken up and given due consideration.

The editor of MINES AND MINERALS will at all times be glad to receive suggestions in regard to this, as well as every other department of the journal, and if any of the articles suggest questions, send these questions to the editor and he will try to have them answered.

The Prize Contest section of Practical Mining Studies offers an opportunity to those who wish to test their knowledge of mining theory, and no better preparation for an examination can be imagined than to participate in this contest.

The Correspondence section also offers an opportunity to those who have original ideas to make public, and if troubles are met with in daily practice by any of the readers of MINES AND MINERALS, write to the Correspondence Department about your difficulties and they will be considered by the editorial staff of MINES AND MINERALS and by every one of the 9,000 subscribers to the journal.

A FLOATING EXPORT EXPOSITION.

THE Chief of the Bureau of Statistics of the Treasury Department has recently suggested a floating exposition to enable American manufacturers and exporters to exhibit their goods at the very doors of the people to whom they wish to sell them. This proposition was originally made before the National Board of Trade, and through the columns of the National Geographic Magazine. In his article in the Geographic Magazine, Mr. Austin says:

"Exhibitions of the products of industry have proved beneficial to trade wherever undertaken, whether the ancient 'fair' or the more modern 'exposition.' The traveling salesman with his sample cases has become a necessity of modern mercantile success; 'commercial museums' exhibit to the dealers of one country the class of goods required in other lands, and the great European nations now send out 'commercial missions' to inquire into and report upon the trade opportunities in distant countries.

"But each of these methods has its limit of influence. The fair or exposition is dependent for its success upon the number of people it can attract to its doors, the traveling salesman represents but a single establishment or industry, the commercial museum conveys its information only to the seller and not to the buyer, and the commercial mission gathers information regarding the wants of distant people, but is unable to offer them samples of the goods which its own people have to meet those wants.

"Why not combine the valuable features of these various aids to commerce in a single great enterprise—a 'floating exposition,' which shall carry samples of our merchandise to the very doors of the people whose trade we would foster, and by bringing the buyer and seller into personal contact establish such mutual understanding of wants and conditions as to facilitate the interchange for which each is desirous?

"If a floating exposition were systematically organized, loading one vessel with exhibits of foodstuffs, another with textiles, another with agricultural implements and vehicles, another with manufactures of iron and steel, another with household requirements, and another with 'Yankee notions,' and sent from port to port and continent to continent, it should prove highly advantageous to our commercial relations with all of the countries visited.

"Every manufacturer or exporter sending an exhibit would naturally send with it a capable representative, who could discuss with the local merchant the qualities of his goods, and their fitness or unfitness for local markets."

The first fruit of this suggestion is the announcement that a floating exhibition to visit the cities bordering on the Gulf of Mexico and the Caribbean Sea has been organized at Buffalo. This expedition is scheduled to leave in the autumn of the present year. A number of enterprises of a similar character have been suggested.

As an example of the manner in which the same idea has been taken up by an organization in Hamburg, Germany, the following description is of interest:

"The earliest exhibition of this kind was organized about two years ago, and it must be said that the results of the enterprise were in excess of the most sanguine expectations. Total value of transactions, \$5,236,000, at a cost of about \$100,000. The details of operation are stated as follows:

"The syndicate addresses to manufacturing and commercial firms circulars explaining the purpose of the exhibition and the terms of participation. As soon as the number of would-be participants is large enough to permit the

loading of a vessel, the exhibitors send their samples to the port of departure. These samples are then mounted and exhibited on board the vessel, especially fitted for this purpose.

"Alongside of each exhibit there is an advertisement giving prices and terms of sale. Sales agents representing either the syndicate or the individual exhibitors furnish all desired information to the visitors at the various ports where the vessel stops. These sales agents are chosen from among the young men as well as the young women graduated from commercial schools and speaking at least two languages. Interpreters are hired on the spot in each country of a new language. The sales agents, besides seeing visitors aboard the ship, visit also with their samples the towns in the interior of the country. In such manner the cost of transportation is greatly reduced.

"The exhibitors pay to the syndicate a commission to be deducted from the realized sales and in proportion to the value of the product. In addition to this commission the participants pay a proportionate share of the cost of chartering and loading the vessel and the general expenditure of the undertaking, such as the hire of clerks, interpreters, etc."

WARNING.

READERS of MINES AND MINERALS are warned to beware of a person who claims to be the son of the late Sir Jos. Whitworth of the firm of Armstrong, Whitworth & Co. This person claims to be traveling in the United States in the interests of Messrs. Armstrong, Whitworth & Co., of Manchester, England, and to be buying machine tools for them. He has acquired a knowledge of the managers and superintendents of the leading American toolmakers and has a very glib story. He is about five feet ten inches in height, rather slender, well-dressed, and has lost several of his front teeth. We have been notified by Messrs. Armstrong, Whitworth & Co., that the late Sir Jos. Whitworth left no children and that the person above described is an impostor.

CORRECTION.

IN the March issue of MINES AND MINERALS under the heading "Fake Prospecting Instruments," the following statement appeared: "It seems scarcely necessary at the beginning of the 20th century to caution persons against being fooled by such manifest frauds, but from the number of inquiries that we have received and from the fact that this P. & M. Agency has been given a favorable rating in the reports of Dun's Commercial Agency it is evident that it is prospering upon the ignorance and gullibility of a certain class of people."

This statement is somewhat misleading, as the P. & M. Agency does not appear under this name in Dun's book of ratings. Mr. A. G. Stauffer, however, is rated in this book and Mr. A. G. Stauffer is said to be the manager and owner of the P. & M. Agency, so that the sense of the above quotation is strictly correct although its actual wording may be somewhat misleading. Mr. A. G. Stauffer claims to have discontinued the P. & M. Agency April 1st.

THE Geological Survey of Texas has been reorganized with the following force of officers: Director, Wm. B. Phillips, Ph. D., Professor of Field and Economic Geology in the University of Texas; Assistant Geologist, Benjamin F. Hill; Chief Chemist, Dr. H. W. Harper, Professor of Chemistry of the University of Texas; Assistant Chemists, O. J. Palm and S. H. Worrell. The first work of the Survey as outlined by the Director includes a preparation of a report upon petroleum, which will be most welcome and which will be very timely in view of the petroleum excitement in Texas at the present time. This will be followed by an exploration of and report upon the Public Lands in the Trans Pecos Country, and as this country is said to contain oil, cinnabar, salt, silver, gold, copper, lead, tin, and uranium, a report upon it should make a most interesting and valuable addition to our geological literature.

All of the scientific collections, publications, etc. of the former survey have been loaned to the University of Texas and have already been removed and set up at that place, thus forming a nucleus for a fine collection, especially with respect to Texas material. The Survey is also operating a chemical laboratory at which regular fees are charged for all work done, which does not interfere in any way with private chemists, assayers, etc.

BOOK REVIEW.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, ANNUAL CATALOGUE 1900-1901. 389 pages.

PAN-AMERICAN EXPOSITION, ITS PURPOSE AND ITS PLAN. Mark Bennitt, Supt. Press Department Pan-American Exposition Co. 48 pages.

BULLETIN OF UNIVERSITY OF MINNESOTA, Vol. IV, No. 4, by the Registrar, University of Minnesota, Minneapolis, Minn. Published by the Board of Regents. 35 pages.

MINES AND QUARRIES, GENERAL REPORT AND STATISTICS FOR 1900. Published under the direction of the Secretary of the Home Department, London, England. 11 pages.

CALENDAR 1901-1902 OF THE ONTARIO SCHOOL OF PRACTICAL SCIENCE, by the Faculty of Applied Science and Engineering of the University of Toronto, Toronto, Ont., Can. 129 pages.

PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY, Chas. D. Walcott, Director, Washington, D. C. The Production of Feldspar and Quartz in 1899, 4 pages. Production of Clay in 1899, 4 pages. The Production of Coal in 1899, by Edward W. Parker, 203 pages. Clays and Clay Products at the Paris Exposition of 1900, 28 pages. An Occurrence of Tungsten Ore in Eastern Nevada, by F. B. Weeks, 2 pages. The Production of Gold and Silver in 1899, 9 pages. Tungsten, Molybdenum, Uranium, and Vanadium in the U. S., by Joseph Hyde Pratt, 20 pages. The Production of Nickel and Cobalt in 1899, 5 pages. General Map of the Anthracite Coal Fields of Pennsylvania, including a diagram and tables showing annual production of anthracite coal since 1820, by regions.

BIENNIAL REPORT OF THE STATE GEOLOGIST OF MISSOURI. Leo Gallaher, Acting State Geologist, Jefferson City, Mo. Pamphlet 55 pages. This is an excellent plea for an increased appropriation for the geological work in the State of Missouri, and the acting geologist has mapped out a most extensive plan of work. It has been a constant source of regret to geologists and mining men that the very excellent work begun in Missouri by Williams, Winslow, and Keyes should have been allowed to lapse for lack of sufficient funds, and any change in the present unsatisfactory condition of the geological survey will be welcomed.

PETROLEUM, ITS PRODUCTION AND USE, by Boverton Redwood. Published by D. Van Nostrand, New York. 209 pages. Price 50 cents. This little book has been so long before the public as to scarcely need mention, but the present interest that is being taken in everything published upon the subject of petroleum warrants at least a statement of its contents. Chapter 1 deals with the general geology and distribution of petroleum. Chapter 2 is a brief description of the methods of drilling and boring. Chapter 3 takes up the consideration of the technology of petroleum and its refining. Chapter 4 deals with the burning of petroleum.

THE LAW OF PETROLEUM AND NATURAL GAS, by Geo. Bryan, Titusville, Pa. Published by Geo. T. Bisel, Philadelphia, Pa. 521 pages. Price \$5. Although published in 1898, this book will receive especial attention at the present time when there is so much excitement in oil throughout the entire West. The book treats strictly upon the law in petroleum cases, and does not purport to take up other branches. During the two years since it has appeared, it has been well received by the legal profession and is a valuable book for any one having to deal with the complicated legal matters in connection with consideration of the petroleum problem.

REPORT OF THE FOUR INSPECTORS OF MINES FOR GREAT BRITAIN ON THE METHODS OF PREVENTING FALLS OF ROOF ADOPTED AT THE COURRIERES COLLIERIES. Published by the Secretary of the State for the Home Department, London, England. 26 pages. About nine months ago a recommendation was made by the Home Department on Methods of Preventing Falls of Roof in English Mines, based upon the methods used in the Courrieres Collieries, France, and exhibited at the Paris Exposition. These recommendations were not received with particular favor by the mining men of Great Britain. Thereupon the Secretary of State sent four inspectors of mines to visit the collieries at Courrieres and the Report here noted is the result of their visit.

THIRTY-FIRST ANNUAL REPORT OF THE BOARD OF DIRECTORS OF CITY TRUSTS OF PHILADELPHIA. The report of the mining department of the Girard Estate by Major Heber Thompson, Engineer of the Girard Estate of Pottsville, is the portion of the report of interest to mining men. 237 pages. As has been the case with Major Thompson's reports for a number of years, the report for 1900 contains a large amount of statistical matter in connection with the mining of anthracite coal. The output from the Girard Estate was less during 1900 than during the previous year, owing

to the closing of several collieries and also to the strike, which decreased the production throughout the entire region. The report shows the estate to be in an excellent condition.

FOURTEENTH ANNUAL REPORT OF THE STATE COAL MINE INSPECTOR FOR MISSOURI FOR THE YEAR ENDING JUNE 30, 1900, Chas. Evans, Inspector of Coal Mines, Jefferson City, Mo. 202 pages. The material in this report is well presented and it is to be regretted that it is so late in publication that the statistics are practically out of date. In addition to the usual accounts of production, accidents, labor troubles, etc., Mr. Evans has included several short articles on Production of Coal in the United States, The Coking of Missouri Coal, Miners' Oil, and Miners' Earnings.

A MEMORIAL OF GEORGE BROWN GOODE. PART 2 OF THE UNITED STATES NATIONAL MUSEUM, for the year ending June 30, 1897. This contains an introduction by the present Director of the National Museum, Dr. C. D. Walcott, together with an account of the Memorial Meeting held after the death of Mr. Goode. It also contains a memoir of George Brown Goode, by Professor Langley, and also a number of his best known papers upon Museums and natural history. Also a list of the publications of Mr. L. T. R. I. Geire. The work is copiously illustrated with 109 photographs of prominent scientists, and is a most valuable addition to any library. It will be welcomed by the scientific world as putting in permanent form the works of a well-known, thoroughly respected, and much loved scientist.

NICARAGUA OR PANAMA, by Philippe Bunau-Varilla. A pamphlet containing the substance of a series of conferences made before the Commercial Club, of Cincinnati; before the Engineers' Club, of Cincinnati; before the Commercial Club, of Boston, under the auspices of the National Business League in Chicago; before the Princeton University in New Jersey, etc., and of a formal address to the Chamber of Commerce of the State of New York. Published by The Knickerbocker Press, of New York. 32 pages. This is a statement of the claims of the Panama Canal for superiority over the proposed Nicaraguan, and is evidently one of the means taken by the Panama Canal people of unloading upon America what has proven such a disastrous enterprise for the French for so many years past. The case of the Panama Canal is briefly and clearly stated, and it is up to the advocates of the Nicaraguan to put its case in an equally clear and practical manner.

CLAYS AND CLAY INDUSTRIES. Bulletin No. 7, Part 1, Wisconsin Geological Survey, by E. R. Buckley, Ph. D., Assistant Superintendent Wisconsin Geological and Natural History Survey. Published at Madison, Wis. 304 pages, profusely illustrated. This Report of Dr. Buckley's is presented in the same excellent manner as was the previous bulletin of the Wisconsin Survey upon "Building Stones." It is well printed and excellently illustrated. As preliminary to the description of the clay working plants at present being operated in the State, he has taken up the origin and composition of clays, which is followed by a classification of the clays together with their properties and behavior under various conditions. This is followed by a description of the clay deposits of Wisconsin and the methods of manufacturing brick and drain tile. Then comes a description of the various clay areas in the State. An appendix gives the method employed in the examination of clay deposits and the book closes with a large number of analyses of Wisconsin clays.

OIL ANALYSIS, by Augustus H. Gill. Second edition, revised. Published by J. B. Lippincott Co., Philadelphia, Pa. 143 pages. Price \$1.50. This work is a concise manual for the analysis of oils and gives the methods of applying the usual physical and chemical tests to the mineral as well as to the animal and vegetable oils. The author does not claim it to be comprehensive, and states distinctly that it is simply an introduction to the more elaborate works upon the same subject. The user of the book is assumed to have some proficiency in organic chemistry and to be familiar with the usual operations of volumetric and gravimetric analyses. The first and second chapters treat of petroleum products, Chapter 1 dealing with burning oils and Chapter 2 with lubricating oils, and it is these two chapters that are of particular interest to mining men, although the succeeding chapters upon other varieties of oil are of interest. The book is well printed and contains a large amount of information concisely stated which will be of interest to any one having to deal with the technology of petroleum.

TUNNELING, by Chas. Prelini, C. E., with additions by Chas. S. Hill, C. E., Associate Editor Engineering News. 150 diagrams and illustrations. Published by D. Van Nostrand Co., New York. Price \$3. 311 pages. The author in his preface gives due credit to Drinkers' monumental work on tunneling, which he rightly states is too voluminous and too expensive for the beginner and for the ordinary reader. He also refers to Simm's Practical Tunneling as a standard for English methods

of some years ago. He states that it has been his purpose to furnish a book of convenient size and moderate price which will explain the operations that are required in tunneling and which will illustrate them by suitable examples taken from actual practice. In this attempt he seems to have been very successful, and when it is considered that Mr. Prelini is a foreigner and has been in this country only a few years, he seems to have covered the ground remarkably well. His limited experience in America has, however, been compensated for by the fact that the book has passed through the hands of Mr. Chas. S. Hill of the Engineering News. The book is well printed and excellently illustrated and will be very welcome to all engineers who do with the work of excavation.

FOURTEENTH ANNUAL REPORT OF THE LEAD AND ZINC MINE INSPECTOR OF THE STATE OF MISSOURI. Geo. E. Quimby, Inspector, Jefferson City, Mo. 211 pages. Although this report, like the one just mentioned, bears date of transmittal as October 15, 1900, in common with many of the other State reports, its late appearance greatly detracts from its value. Owing to the unfortunate conditions surrounding the printing of many of these State documents this delay seems unavoidable, but nevertheless to be regretted, as promptness in publication is one of the first requisites in a statistical report. This criticism must not be construed as reflecting upon Mr. Quimby, for while we do not know the exact conditions in Missouri we do know from experience in other States that it is almost impossible to secure anything like prompt service from State printers. The introductory chapter of the report is an excellent resume of the conditions surrounding the zinc industry in Missouri and it also applies in great part to other portions of the country. We will not quote from it at present as we hope to publish it entire. The report gives the usual statistics of production, accidents, etc., very excellently worded and clearly, but concisely, stated. It also contains a brief description of every mine in the State and closes with a number of tables giving statistics of accidents, production and like interesting material, all well arranged and clearly presented.

GENERAL MAP OF THE BITUMINOUS COAL FIELDS OF PENNSYLVANIA. Published by Baird Halberstadt, Engineer and Geologist, Pottsville, Pa. 5 ft. $\times$ 4 ft. Price, mounted wall map (size 5 ft. $\times$ 4 ft.) \$5; mounted (folded and bound) (9 in. $\times$ 7 in.) \$5; unmounted in four sheets, \$4. A most valuable map of the Bituminous Coal Fields of Pennsylvania has been published by Baird Halberstadt, Engineer and Geologist, of Pottsville, Pa., formerly assistant to Prof. J. P. Lesley, State Geologist of Pennsylvania. Mr. Halberstadt's long connection with the Survey and his varied experience in the principal coal fields of the United States, and his work as an expert special agent of the 11th U. S. Census has peculiarly fitted him to prepare a map of the greatest practical utility to all interested in the mining, shipping, selling, and transporting of coal, and kindred interests. The map is a large one, being 5 ft. $\times$ 4 ft. in size. Its scale is 4 miles to an inch. The county lines are distinctly marked and colored. Each township is outlined. All the new mining towns have been located. The railways and coal lateral lines are shown in red. In order that the map might not be overcrowded, the geology is shown in two separate colors. The Coal Measures have been divided into two classes, namely, those lying above and including the Pittsburgh coal bed, and the lower measures and the Pottsville conglomerate, containing the lowest coal beds. Upon the map are located all the commercial coal mines in the Bituminous region of Pennsylvania. An accompanying list printed on the map gives the names of the mines, the operators, their post-office addresses and the name of the initial railway or waterway by which the coal goes to market. To make the whole more complete, a small map shows the outlets to market, and includes in part the States of Ohio, West Virginia, Maryland, Virginia, District of Columbia, Delaware, New Jersey, New York, Connecticut, and Massachusetts. Thus it will be seen that all the routes to market North, East, South, and West, including tide and lakes are shown. This map should have a place in the office of every operator, railway company, sales agent, bank and trust company, and engineer—not only in Pennsylvania but in neighboring States as well.

A Special Boot for Mining Men.

Every mining engineer, mine official, and prospector realizes that a pair of comfortable, durable, and waterproof boots forms a most important part of a mining man's equipment.

To ensure the greatest comfort, such a boot must not only protect the feet, but must also be so constructed as to protect the ankle joint and lower leg without affecting freedom of action.

For the past twenty-five years, Messrs. H. J. Putman & Co., of 38 Hennepin Ave., Minneapolis, Minn., have made a specialty of the manufacture of boots for prospectors, mining engineers, mine officials, and sportsmen. That they have succeeded in producing a satisfactory boot is evidenced by the fact that more

Putman boots are used by such classes than any other make.

Messrs. Putman & Co. have not endeavored to place on the market a cheap boot. What they have done is they have produced a boot which is economical on account of great durability, as well as comfortable and convenient.

Their facilities for filling mail orders are most excellent. On request they cheerfully send a catalogue of thirty different styles, with an order blank showing how to measure the foot so as to secure a perfect fit. They guarantee every pair of their boots to be up to specification, and their guarantee is a good one. We have no hesitancy in stating that Messrs. H. J. Putman & Co. rank among the most responsible business men of Minneapolis. An illustration of the general style of their prospectors', engineers', and mine officials' boot is given in their advertisement in this issue.

PERSONALS.

Frank C. Smink, secretary and treasurer of the Reading Iron Co., has been appointed president of that company to take the place of Mr. Baer.

Mr. L. E. Aubury, has been appointed State Mineralogist of California. He is also second vice-president of the California Miners' Association.

Mr. Thos. Lynch, president of the Frick Coal & Coke Co., has been made general manager of the coal and coke properties of the United States Steel Co.

Mr. Wm. Magenau, formerly engineer for the Columbia Lead Co., of Eather, Mo., has recently been made superintendent of the Catherine Lead Co., of Fredericktown, Mo.

Mr. Harry Rolfe of The International Correspondence Schools, Scranton, Pa., has accepted an important position in the mechanical engineering department of the Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.

Mr. H. F. J. Porter, formerly manager of the Chicago office of the Bethlehem Steel Co., and more recently located at the works at South Bethlehem, has been appointed New York sales agent of the company, with headquarters at No. 100 Broadway.

Mr. Jos. Oliver, superintendent of the Prairie Creek Coal Co., of Huntington, Ark., and son have recently been making a tour of inspection through the anthracite region of Pennsylvania, studying the conditions in connection with the preparation of anthracite coal, with a view to adopting Pennsylvania practice in connection with the semi-bituminous coals of Arkansas.

Gov. Richards of Wyoming, has appointed Prof. H. C. Beeler of Cambria, Wyo., as State Geologist, and the first incumbent of the newly created office will take charge on June 1. Prof. Beeler is a young man, and for several years has been chief engineer in charge of the vast mining interests of Kilpatrick Bros. & Collins. He is a graduate of the Colorado School of Mines at Golden.

Ex-mine inspector T. D. Jones of Hazleton, superintendent of the Mill Creek Coal Co., has resigned his superintendency and is succeeded by his son, Elmer Jones. The former is known in mining circles as one of the most successful superintendents in the anthracite coal fields. He has been identified in the Hazleton region with coal matters for the past thirty years. His son, who takes his place, is a graduate of Columbia School of Mines.

Mr. S. D. Warriner who has been superintendent of the Calumet & Hecla Mining Co., of Calumet, Mich., for the past five years has resigned that position to become general manager of the Lehigh Valley Coal Co., Wilkes-Barre, Pa., vice W. A. Lathrop, resigned to become president of the Webster Coal and Coke Co. Mr. Warriner was connected with the mechanical department of the Lehigh Valley Coal Co. before going with the Calumet & Hecla Co.

The annual meeting of the stockholders of the Joseph Dixon Crucible Co. was held at the company's main office, Jersey City, N. J., Monday, April 15, and out of a possible vote of 7,345 shares, there were 7,285 shares voted for the reelection of the old Board, consisting of Edward F. C. Young, John A. Walker, Daniel T. Hoag, Richard Butler, William Murray, Edward L. Young, and Joseph T. Bedle. President E. F. C. Young; Vice-President and Treasurer John A. Walker; Secretary George E. Long, were reelected by the directors. Judge Joseph E. Bedle was also reelected as counsel.

At a recent meeting of the directors of the Philadelphia & Reading Railway and the Philadelphia & Reading Coal & Iron Co., the office of third or financial vice-president was created and was filled by the appointment of Wm. R. Taylor, formerly secretary of the Reading Co. Mr. Taylor was born in Schuylkill-Haven, Schuylkill County, Pa., May 1856, and in 1871 entered the service of the Philadelphia & Reading Railway Co. In 1876 he was appointed stenographer to President Gowen and remained with him until his resignation of the presidency in 1884. Mr. Taylor continued with Mr. Gowen's successor, Geo. De B. Keim. In

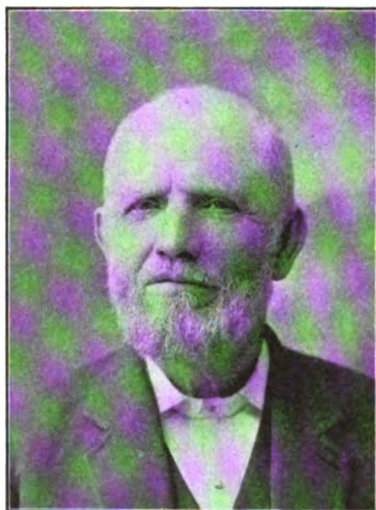
1886, Mr. Taylor was elected secretary of the company, which position he has held until the present appointment through the various changes in management and organization of the Reading Road. As vice-president, Mr. Taylor will have supervision of the offices of the secretary, treasurer and accountant of all the corporations in which the Reading Co. has an interest.

A partnership has been formed by B. M. Gardner and Charles R. Robinson, under the firm name of Gardner & Robinson with office at 1522 Monadnock Blk., Chicago, to deal in iron and steel products. Both Mr. Gardner and Mr. Robinson have been in business in Chicago for a number of years. Mr. Robinson was formerly in the sales department of the Chicago office of Singer, Nimick & Co., and has been in the iron and steel business for over ten years. He is very well known to the trade, and his wide acquaintance among users of iron and steel will be of great value to the new firm. Mr. Gardner has been the Western representative for the Iron Trade Review for the past nine years, with office in Chicago, and has a large acquaintance among the trade. Gardner & Robinson have secured the sales agencies of the following concerns for Chicago territory: Seaboard Steel Casting Co., of Chester, Pa., manufacturers of open-hearth steel castings up to 80,000 lb. in weight; Acme Steel & Malleable Iron Works, Buffalo, N. Y., manufacturers of "Acme" and "Ductile" steel castings and malleable-iron castings; New Brighton Steel Co., New Brighton, Pa., high-grade crucible tool steel, bars and sheets, and tool-steel forgings. They also handle "Motar Metal," a high-grade antifriction metal.

OBITUARY.

HON. DANIEL EDWARDS.

Hon. Daniel Edwards, of Kingston, Pa., died at his residence in that city in the early morning of Saturday, May 18. The deceased had been in his usual health at the time of retiring at 11 o'clock the evening previous to his death, and had been busy all day attending to business matters. As was his custom, he had visited the Gaylord Mine at Plymouth and his other mines at Edwardsville during the afternoon. He spent the evening with



friends, retiring about 11 P. M., and shortly afterwards he was discovered by his son-in-law, Dr. Cobleigh, to be in a dying condition, passing away an hour after he was first discovered.

Mr. Edwards lived in Wales until he reached his majority, but 45 years ago emigrated to America, and in 1858 became superintendent of the iron mines at Danville, Pa., then owned by Waterman & Beaver. In 1876 he took charge of coal mines at Kingston, Pa., and his untiring energy and thorough knowledge of the business have contributed largely to the rapid development of the coal industry in that vicinity.

Mr. Edwards was of a modest and retiring disposition, and as his extensive business relations occupied his time almost wholly, he did not cultivate a large circle of acquaintances. Those who knew him, however, appreciated his sterling integrity and his retiring and unobtrusive character. He was an indefatigable worker, and through strict attention to business he built up a fortune. He was president and general manager of the Kingston Coal Co., president of the Kingston Bank and director of the Wilkes-Barre City Hospital. He was a member of the Edwardsville Welsh Congregational Church and his name will always stand high in the list of Cambria's sons, to whom the anthracite region of Pennsylvania owes so much.

REV. EDWARD S. PHILLIPS.

The Rev. Edward S. Phillips, of Hazleton, Pa., in charge of St. Gabriel's Roman Catholic Church of that city, and who has come to be very well known, particularly within the past year on account of his active interest in connection with the coal strike and for the prominent and important part he took in effecting a compromise of that strike, died in New York City early in the month of May. He was buried from St. John's Roman Catholic Church, Pittston, Pa., May 20, and the funeral was attended by a large number of his parishioners of Hazleton and a large number of Catholic societies from that section. His death will

be a distinct loss to the cause of labor in the anthracite region, as he has been very active in all measures looking toward a compromise of the strained relations which have existed in the anthracite region during the past twelve months.

ALEXANDER AIKMAN.

Alexander Aikman, for the past sixteen years inside foreman at the Dickson mine of the Delaware and Hudson Co., died at his home, 630 East Market Street, Scranton, Pa., Wednesday, May 8, at 9 o'clock A. M. Mr. Aikman was 60 years of age. He was a native of Anchinairn, Scotland, and came to America when a child. A few months ago he returned to his old home hoping to regain his lost health.

CATALOGUES RECEIVED.

In writing for catalogues, please mention Mines and Minerals.

BALL ENGINE CO., Erie Pa. A Few Illustrations. Illustrations only. 18 pages.

CLARK BROS. CO., Vicksburg, Mich. Practical Economy for Steam Users. 24 pages.

PEERLESS RUBBER MFG. CO., 16 Warren St., New York. Rainbow Packing. 32 pages.

WATT MINING CAR WHEEL CO., Barnesville, Ohio. Good Measure in Cars. 6 pages.

THE WAGNER-PALMROS MFG. CO., Fairmont, W. Va. Coal Mining Machinery. 4 pages.

THE CONNERSVILLE BLOWER CO., Connorsville, Ind. Catalogue No. 3. Illustrated. 32 pages.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Dixon's Perfected Graphite Brushes. 16 pages.

BACKUS WATER MOTOR CO., 172 Pennsylvania Ave., Newark, N. J. Backus Water Motor, illustrated. 36 pages.

BULLOCK ELECTRIC MFG. CO., Cincinnati, O., and WAGNER ELECTRIC MFG. CO., St. Louis, Mo. A Step Forward. 6 pages.

NATIONAL PAINT WORKS, Williamsport, Pa. A Review of Technical Paints for the Protection of Metal Surfaces. 32 pages.

C. W. HUNT CO., West New Brighton, Staten Island, N. Y. An introduction to C. W. Hunt Co. 15 pages. Industrial Railways. 15 pages.

GENERAL MAP OF THE BITUMINOUS COAL FIELDS OF PENNSYLVANIA, 1901. Baird Halberstadt, Geologist and Engineer, Pottsville, Pa. 11 pages.

CENTRAL ELECTRIC CO., 264 Fifth Ave., Chicago, Ill. Price List, I. X. L. Weather Proof Wire, Double Galvanized Telephone Wire, Magnet Wire and Lamp Cord. 4-page folder.

STEEL CABLE ENGINEERING CO., 120 Liberty St., New York. Mechanical Methods of Handling and Conveying Coal, Coke, Ashes, Ore, and Similar Materials. Illustrated. 43 pages.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Alternating-Current Fan Motors. 4 pages. Lightning Protection. 20 pages. Multipolar Generators and Motors. 19 pages. Generators and Rotary Converters for Electrolytic Work. 20 pages. Direct Connected Railway Generators. 12 pages.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4246, Power Circuit Enclosed Arc Lamps for 220 or 550 Volts. 8 pages. Parts of Form 1 Direct Current (Series) Power Circuit Arc Lamps for 220 and 500 Volts. 17 pages. Parts of Form 1 Carbon Feed Alternating Constant Current (series) Enclosed Arc Lamps. 11 pages. Parts of Carbon Feed Enclosed Arc Lamps Form 3 for Alternating Current Multiple Circuits. 11 pages. Parts of LWP-5 Motors. 13 pages. Parts of Form 3 Carbon Feed Direct Constant Current (Series) Enclosed Arc Lamps. 11 pages.

The International Mining Congress.

The fourth annual session of the International Mining Congress will assemble at 10 A. M. Tuesday, July 23, 1901, in the Columbia Hotel, Boise City, Idaho. The sessions of the Congress are announced to extend over the 24th and the 25th. The following extract from the circular of announcement gives the objects of this congress: It is not the object of this Congress to confine its consideration alone to that of mining for Gold and Silver and their by-products, but that of iron, coal, marble, stone, the various fireclays, asphaltum and all kindred interests of the mineral and metallic classes. To secure better recognition of the mining industry by the National Government.

To bring about needed changes in the Federal Mining Laws.

To cultivate acquaintance, fraternal feeling and hearty cooperation among the various mining, manufacturing, transportation, commercial, and labor bodies represented.

To exchange practical ideas covering the various phases of the mining business; an interest embracing every branch of the mining industry and especially to take under advisement the importance of the creation by the Congress of the United States, of a department to be known as the Department of Mines and Mining,

thus securing a cabinet officer that represents an interest which effects more than one-third of the people of the United States, producing in 1900 over one billion of dollars.

Governors of states and territories, all friendly nations, mayors of cities and towns, mining exchanges, chambers of commerce, boards of trade, real estate exchanges and all commercial, trade and labor organizations are urged to appoint representative delegates at an early date, sending the name and post-office address of each delegate to the secretary.

BASES OF REPRESENTATION.

The governor of each state and territory to name 30 delegates at large. The county commissioners of each county to name five delegates at large.

The following organizations are each entitled to name five delegates:

The mayor of each city and town to name five delegates at large, and one additional for each ten thousand population of fraction thereof.

Each mining bureau, mining exchange, real estate exchange, chamber of commerce, board of trade, miners' union, trade and labor assembly, and all other commercial bodies.

TRADE NOTICES.

The Ball Engine Co., Erie, Pa., is building two 450 H. P. engines for the Norfolk Coal & Coke Co., of Maybeury, W. Va.

Vickers, Sons & Maxim, the largest manufacturers in the world of war material, who have immense works in England, and supply all the foreign governments, have recently equipped their plant with Cross oil filters manufactured by the Burt Mfg. Co., of Akron, Ohio.

Wm. B. Scaife & Sons, Pittsburg, Pa., have received a contract from Spang, Chalfant & Co., for extensive additions to their Etna Tube Works. A number of large steel frame buildings covered with corrugated iron will be erected, involving a heavy tonnage of structural material.

The International Boiler Works, East Stroudsburg, Pa., within the past forty days has received orders for a large number of steam boilers. Among the number were three 72" x 18" for the Suburban Electric Light & Power Co., Scranton, Pa.; four of same dimensions for the Atlantic City, N. J., Electric Co.; four 66" x 16" for Northern Anthracite Coal Co., Lopez, Pa., and five vertical boilers for J. S. Mundy, of Newark, N. J. Trade has been unusually good for the past six months.

In a recent letter received by the Ericsson Telephone Co., 298 Broadway, New York, the United States Signal Office wrote as follows: "Referring to the order of this date placed with you for 200 bridging telephones, this office desires to state that as you are probably aware in the early part of 1900 we shipped a lot of telephones of six different makes to Manila for testing purposes. The report upon the Ericsson Telephone has been favorable." As a further commentary, it might be added that the Signal Office of the War Department in this same letter ordered a second lot of telephones from the Ericsson Co. for use in Manila.

The B. F. Sturtevant Co., of Boston, Mass., is rapidly recovering from the effects of the fire of April 14 which affected only the engine and electrical departments. With only a day's delay incident to the renewal of belts the remainder of the plant has been running as usual. Already a complete new equipment of improved machine tools is nearly installed in other buildings. As the Sturtevant Co. employs electric transmission for the driving of a considerable portion of its tools, this work of installation has been a comparatively simple matter. Further delay in shipment of engine and electrical work is unlikely for no patterns or drawings were destroyed, and the foundry with a large stock of castings is intact.

The Ironsides Co., of Columbus, Ohio, report the business of their past fiscal year just closed, as showing a gratifying increase. Their business is the manufacture and supply of special lubricants for the preservation and protection of metallic surfaces, wire ropes, gearing, belting, fiber ropes, etc. Their market includes the largest rolling mills, general manufactories, mining and other industrial institutions, whose decreased expenses in operating departments attest the value of the goods. Late improvements and extensions of their factory provide for a further increase of one hundred per cent. in their business the coming year, which they anticipate.

The Pacific Tank Co., of San Francisco and Los Angeles, Cal., has issued a very neat and serviceable souvenir in the form of a wooden tank. The top of this is made of bark and serves as an excellent pin cushion. This company manufactures tanks of every description and is particularly celebrated for its patent non-shrinking and for its plain water tanks. The advantages of a good water tank are many and nothing is more annoying about a

mining plant than a water tank which leaks and which is continually dripping. All those interested in such tanks will therefore do well to correspond with the Pacific Tank Co., addressing communications either to the San Francisco or Los Angeles office.

On account of the Pan-American Exposition the following round trip rates and arrangements will be in effect from Scranton, via Lackawanna Railroad. Season tickets will be sold commencing April 30 and on every day thereafter during the exposition, limited for return until November 30, inclusive, \$11.20. Ten-day tickets will be sold commencing April 30 and on every day thereafter during the exposition, \$8.00. Five-day tickets will be sold commencing April 30 and on every Tuesday and Saturday thereafter during the exposition, \$6.00. All tickets will be honored in sleeping or parlor cars in connection with proper Pullman tickets, except the five-day tickets, which will be honored in day coaches only. Children between the ages of five and eleven years, one half of the above rates.

The Atlas Pipe Wrench Co., of New York and San Francisco, will have a complete exhibit of pipe wrenches in the coming Pan-American Exposition at Buffalo, N. Y. All sizes of the wrench will be on exhibition and a practical demonstration of the same will be given by an expert workman. All the uses to which the pipe wrench is put, by the steam fitter, plumber, engineer, and all other users of pipe wrenches will be shown by the workman, and the superiority which is claimed for the Atlas pipe wrench will be shown at all times to those visitors interested in pipe fitting and the advances made in tools for that purpose. Quality of the steel used in the manufacture of the Atlas pipe wrench and the finish and workmanship will be shown in wrenches in their various stages of manufacture from the "bar steel" to the "finished product." Atlas pipe wrenches are now on sale by hardware, plumbing, and engineering supply dealers throughout the United States and Europe.

In Government work the Lundell motors and generators, manufactured by the Sprague Electric Co., are used to a very large extent. Recent orders include seventeen motors of various sizes for the Norfolk navy yard; three 35 H. P. motors for the Mare Island navy yard; four motors for the Boston navy yard, to be used on metal working machines furnished by Geo. A. Ohl & Co., and five motors, one generator and a 2 K. W. ventilating set for the Brooklyn navy yard. In addition to the Government orders, the Sprague Electric Co. reports the following among its large sales: Steelton Light & Power Co., one 125 K. W. belted type generator; Columbia University, three 75 K. W. engine type generators; C. S. Ashley, one 125 K. W. generator; Pittsburg Reduction Co., one 25 H. P. motor and one 168 H. P. motor; National Meter Co., one 37½ K. W. engine type generator; Chase Rolling Mill Co., one 125 K. W. belted type generator, and the Evansville Gas & Electric Co., one 150 K. W. generator.

The Keystone Driller Co., of Beaver Falls, Pa., is enjoying a very brisk run of business. At a meeting of directors held April 18, it was decided to increase the present plant to double present capacity. The increased floor space will be 300 x 200 feet, and will be used for machine shop, boiler shop, and erecting room. The first week in April two carloads of oil well machinery were shipped to the new oil fields in California, and in March a Keystone driller and a man to operate it went to Vladivostok, Siberia. The same company has an order from W. P. Hammon, of Oroville, Cal., for two No. 2 traction placer-testing Keystone drillers. Mr. Hammon has had several of these machines in use for the last two or three years in testing placer ground before installing a dredger, and they have proved a great saving in testing the ground, the expense being small compared to that of sinking shafts. The use of these machines has made it possible in many places to put down holes and test the ground where it would have been almost impossible to sink a shaft on account of water, etc.

The Bullock Electric Mfg. Co., of Cincinnati, and the Wagner Electric Mfg. Co., of St. Louis, have consolidated their sales departments, which will be under the management of Mr. E. H. Abadie, formerly sales manager of the Wagner Co. The Bullock plant is admirably adapted to the building of machines of any size, but as the building of auxiliary apparatus has never been engaged in to any extent by this company, it was necessary either to enlarge, or amalgamate with some other concern in the field. The Wagner Electric Mfg. Co. has devoted its energies to the manufacture of auxiliary apparatus such as static transformers, switchboards, etc. Under these conditions, such consolidation as has been made should be mutually advantageous. Each company will operate its own works independent of the other, the cooperative arrangement applying only to the sales organization. All territory east of the 35th meridian will be handled by the Bullock Co., while all territory west of that line will be in charge of the Wagner Co. By this combination blanket contracts can be accepted and everything required for lighting, railway or long distance power transmission plants will be contracted for.

R. C. Chambers, President of the Ontario Silver Mining Company.

Written for MINES AND MINERALS, by Don Maguire.

On April 11, 1901, in the city of San Francisco, Robert Craig Chambers died of appendicitis. He was born at Lexington, Ohio, January 16, 1832, and was therefore at the time of his death in the 70th year of his age. Before Mr. Chambers had reached the age of ten years his parents migrated to the then new State of Missouri, where a new home was begun and to all appearances the life of a frontier farmer awaited every member of the Chambers family.

Then the California gold excitement broke out and in the year 1850 young Chambers with thousands of others took to the overland trail that led to the land of hope and fortune. For a time he was engaged in placer mining and later began the opening of a number of quartz leads in company with others. His first efforts at mining do not seem to have been profitable beyond the average outcome of those days and at the age of 26 he was elected Sheriff of Plumas County, which office he occupied for four years, a position which in those early pioneer times on the Pacific coast required a man of fearless temperament and indomitable courage. He was of powerful build almost six feet in height, and known as a man who could stand the most extraordinary exertions, as was often required on the part of the pioneer public official. He became interested with others in various mining ventures and was for a short time a merchant in Plumas County until the excitement occasioned by the discovery of silver mining in Washoe, when he left California and went into Nevada where he was engaged in mining at Virginia City and at other places. In 1870 when silver and gold discoveries had been made near Salt Lake City he journeyed into Utah where he engaged in mining in the then new districts of Ophir, Cottonwood, and Camp Floyd. His chief work in Utah in those days was the opening of a property for Alexander Majors, the famous government freighter of early times. He next turned his attention to prospecting in the Wasatch range but did not discover anything of any great value until going over into Parley's Park he found two miners who had made a very rich find some days before. Their vein was small but quite rich, the ore outcrop being sulphurets of silver. Mr. Chambers purchased the new find for \$30,000, having associated with him in this purchase, Mr. George Hearst, afterwards Senator from California. This property became the famous Ontario Silver Mine that has up to date produced almost \$35,000,000.

Although through his early years Mr. Chambers had not gained any great success in life, he showed marked ability in every work he had undertaken and proved himself competent to manage any sort of mine development. His judgment was excellent, and when Senator Hearst became associated with him in the then infant Ontario, the development and management fell to the lot of Mr. Chambers, who for more than thirty years watched over its fortunes and made it one of the great silver mines of the world. It was naturally a very rich mine, but situated as it is in a region where the ground is wet as a sponge, timbering and drainage were items the cost of which threatened to preclude the possibility of working the property at a profit. These obstacles Mr. Chambers surmounted, and in the early seventies the Ontario began to pay enormous dividends, which it continued to do until 1894, when it temporarily shut down on account of the low price of silver.

For more than twenty-five years it was the best managed and most profitable mine in Utah. Every feature of modern improvement that could advance the interest of the stockholders, improve the property, or insure the safety of the workmen was carried into effect by Mr. Chambers until the property became to all miners, old and young, as a school where mining in its most thorough methods might be mastered.

His management gave satisfaction to stockholders and workmen alike. The mine flourished, and he became a millionaire

through the earnings of his interests in the property. As a greater area of ground was opened a larger volume of water was encountered, until the largest pumps made in America were required to handle it. These drained the underground workings very well, but the tremendous cost of pumping and the prospect of even a greater volume of water being encountered suggested the necessity of draining the entire workings by means of a drain tunnel five miles in length that would carry the waters of all the mine entirely out of the district and discharge them into a valley beyond the low range of mountains that rise east of Park City. This work was undertaken, and in less than seven years it was completed, the tunnel doing all that was expected of it and moreover furnishing power for a valuable electrical lighting and power plant by means of the waters flowing from its mouth.

On the strength of the Ontario's prosperity the mining camp of Park City became a respectable, clean, and thrifty city. Above and below ground about 1,000 men were employed by the Ontario company.

Mr. Chambers from the profits of his interests in the Ontario made large investments in real estate and mines in California, Montana, Nevada, and he was also a large owner of valuable mining property in Mexico. He stood high as a citizen of Utah, was noted for his generosity and liberal spirit; gave away thousands to public benefits, took pains to establish good schools in Park City and elsewhere. He represented Summit County many terms in the Utah Legislature and was president of the Utah World's Fair Commission to Chicago in 1893, where he and Richard R. Macintosh by their own generous spirit supported the State's credit when the collapse of 1893 broke upon the country. The fall of silver in the years 1893-4 very much impaired the prosperity of the Ontario mine, and also the fortunes of Mr. Chambers, a very large part of his holdings were in silver mines that became unprofitable. The Ontario mine for a time closed its workings. Yet the strong indomitable spirit of its manager watched over its interests; in 60 miles of workings a force of men was kept constantly at work easing timbers, opening new ore bodies, and laying out new lines of development, just enough ore was removed from the mine and worked in the mill to pay the expenses of the mine. Mr. Chambers had faith in the future, believing that, ultimately the interests of silver mining would revive. He saw the shares of the great mine fall from \$50 to less than \$8, yet he did not lose hope and when some weeks ago its stock began to rise, he said with confidence that within three years it would reach its former value. He was a man not easily discouraged and through the hard times of 1893-8 boldly stood up sustaining his credit and helping his friends.

He was a man of warm and kindly disposition and when once men endeared themselves to him by faithful conduct and honesty in his service, he would never desert them in misfortune. The associates of his early years in Plumas County, California, gathered around him in Utah, and he always strove to find work for them in or around the Ontario mine.

Late in life Mr. Chambers married in San Francisco, his wife being Eudora A. Tolles, a lady of rare qualities of mind. She died in San Francisco in 1898, since which time Mr. Chambers evinced a somewhat melancholy disposition from time to time, yet he continued to labor and strive for the advance of every industrial possession he controlled. He was owner of the Salt Lake Herald for many years, this is the chief Democratic journal of Utah, of which party Mr. Chambers himself was a member, and he carried the burden of its expenses through all of the hard times. At the time of his death Mr. Chambers yet held large holdings in this journal. His death removes from the scene one of the most conspicuous of mining men in the intermountain country, and many a man and woman of the Pacific coast will feel down deep in the heart that when R. C. Chambers breathed his last that the best friend of a lifetime had passed away. He was one of those who helped to redeem the wilderness and bring to the site of former barbarism the glories of modern prosperity and civilization.

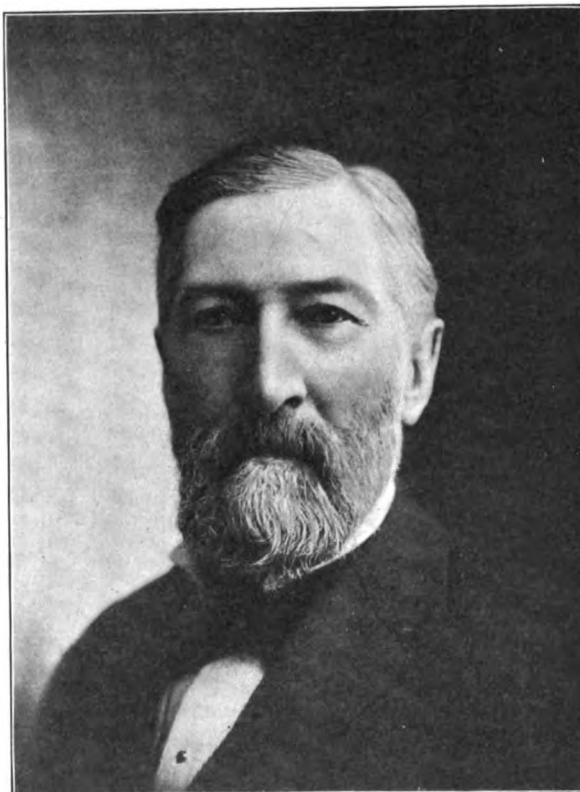


Photo by Johnson, Salt Lake City.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Value of Mica.

Editor Mines and Minerals:

SIR:—Can you give any idea as to the value of mica, the sheets running in size from 8 to 10 inches.

D. W. MILLER.

The value of mica depends entirely upon the quality and the size of the sheets. See reference to above question by W. M. A., Westport, Ont. The paper referred to there will give you much interesting information about mica.

Mica.

Editor Mines and Minerals:

SIR:—Can you refer me to any paper or books treating upon the subject of mica?

Westport, Ont.

W. M. A.

Write to Dr. R. W. Raymond, Secretary American Institute of Mining Engineers, 99 John St., New York City, for paper on Mica Mining read by Prof. J. A. Holmes, State Geologist of North Carolina, at the Washington meeting of the American Institute of Mining Engineers.

Determination of Amount of Water Power.

Editor Mines and Minerals:

SIR:—How can I determine the amount of water going over a mill race of certain size? Knowing the above, how can I determine the amount of power available? Should the answers to the above require too much valuable space, give the titles and authors of any books from which I may get the required information.

Mt. Savage, Md.

W. M. L.

See The Coal and Metal Miners' Pocket Book, 6th Edition, chapter on Hydraulics.

Fireclay.

Editor Mines and Minerals:

SIR:—Replying to the inquiry of T. C. in the May issue of MINES AND MINERALS, there is good fireclay in Blossburg, Tioga Co., Pa. It has been tested, and proved first class. For further information apply to Mr. W. R. Logan, Blossburg, Tioga Co., Pa.

JAMES COX.

Haulage.

Editor Mines and Minerals:

SIR:—In reply to W. J. E., May issue, I would state that a door was placed temporarily in first cutthrough in No. 2, Right Heading on mine plan of Windber mine shown in your March issue. There is a local swamp at that point, the coal dipping both ways, toward the side and back headings called No. 2 Right; hence, door was placed as stated for about three months until conditions changed.

The article and plan in March issue are intended to show the general conditions existing, but when sudden variations of dip are encountered, the plan is flexible enough to meet any particular case. The above door was the only one at that time (December 1900) in eight mines.

Windber, Pa.

J. S. CUNNINGHAM.

Correction.

Editor Mines and Minerals:

SIR:—The May issue of MINES AND MINERALS got to hand today, and in my letter published in the Correspondence column two mistakes are made, one of which is very important, which I hope you will correct in your first issue:

(1) You print "Bent and Hamilton Palace collieries" as "Bart and Hamilton Palace collieries."

(2) In the sixth line you credit me with saying, "In the Bart colliery I put an endless rope haulage." This should read, "In the Bent colliery he (Mr. Dixon) put an endless rope haulage."

Lethbridge, Alta.

W. D. L. HARDIE.

Cannel Coal.

Editor Mines and Minerals:

SIR:—I desire to get some information about cannel coal mines. Are there any operated in the United States? How do they prepare it for market. As run of mine, or do they have different grades? If they have different grades how do they get it, by screening? Is it mined by pick or machines, or is it possible to mine it by machines? What system is used, longwall or room and pillar?

D. C. THOMAS.

Glouster, O.

Mr. E. W. Parker, statistician of the United States Geological Survey, has kindly furnished us the following:

Cannel coal is produced in a number of places in the United States, in some cases being associated with bituminous coal, the cannel occurring in one bench and bituminous in another in the same seam. So far as we know, its preparation for market is not materially different from that of bituminous coal. As it is used principally as a domestic coal in open grates, the screenings are of practically no value and it is desirable to have it mined with as large a percentage of lump as possible. Some of the mines use machines, but in most cases it is mined by hand. In one case only that we know of is the longwall method adopted. The following concerns reported cannel coal to the United States Geological Survey as a whole or part of their production:

Mutual Mining Co., Martin Cahill, Supt., Cannelburg, Ind.
Johnstone Coal Co., D. S. Johnstone, Kalo, Iowa.
Log Mountain Coal, Coke & Timber Co., Pineville, Ky.
Pineville Coal Co., R. Holmgard, Supt., Pineville, Ky. (This concern uses the Independent, or Link Belt, mining machine.)
Kentucky Cannel Co., Sturgis G. Bates, Supt., Riverton, Ky.
Greasy Creek Cannel Coal Co., J. P. Dieter, Supt., Eliza, Ky.
White House Cannel Coal Co., J. H. Northrup, Supt., Louisa, Ky.
East Jellico Coal Co., Fred G. Tice, Sec'y, Coalport, Ky. (Uses Harrison pick machines.)
Whitley Coal Co., Ben W. Robinson, Supt., Halsey, Ky.
Cannel Coal Co., Chas. D. Fraser, Supt., Laredo, Texas.
Falling Rock Cannel Coal Co., L. W. Couch, Supt., Charleston, W. Va.
Campbell's Creek Coal Co., J. E. Dana, Supt., Malden, W. Va. (Uses Jeffrey electric chain breast machines.)
Marmet-Smith Coal Mining Co., Edward Schoenebaum, Supt., Raymond City, W. Va. (Uses Brown electric longwall machines.)

Pipe Line for Steam.

Editor Mines and Minerals:

SIR:—We have a No. 6 Cameron pump in a shaft 32 feet deep at a distance of 1,466 feet from our boiler plant. We would like to have your opinion or some information in regard to conveying the steam from the boilers to this pump. We think a 1½-inch pipe will be large enough, but we suppose we will either have to bury it 2 or 3 feet, or box it up. What proportion of the steam will condense, or what proportion of the power will be lost in this distance? How many expansion joints will be necessary for this length of pipe?

P. R.

A No. 6 Cameron pump 8 in. × 4 in. × 12 in. running at full capacity (100 ft. per min. piston speed) will deliver 65 gallons of water per minute. The discharge head is not given, but as you say the pump is in a shaft 32 feet deep, we assume the lift to be say 50 feet from the bottom of the shaft to the discharge at the surface. For the above pump (8 in. × 4 in. × 12 in.) working under this head (50 feet) a steam pressure of 10 pounds at the pump would be ample, since this would provide for a water head of $\frac{10 \times 4}{.434} = 92$ feet. However, to provide against contingencies we will assume double this steam pressure, or 20 pounds at the pump.

With 20 pounds steam pressure, and running at full capacity (65 gal. per min.), this pump would require 4 pounds of steam per minute. A 2-inch pipe would supply this steam at a distance of 1,466 feet from the boiler, but would require a boiler pressure of 85 pounds. The boiler horsepower that would supply 4 pounds of steam per minute is $\frac{4 \times 60}{30} = 8$ H.P. If the boiler was

stationed at the pump this horsepower would be sufficient for running the pump at full capacity. The horsepower lost in transmission, using an uncovered 2-inch pipe 1,466 feet long, in this case, is practically 16 horsepower. By covering this pipe with 1-inch felt, the loss is only $\frac{1}{10}$ of this amount, or say less than 2 horsepower. The total horsepower required at the boilers would then be, for full capacity of the pump, 8 + 2 = 10 horsepower for a pipe covered with felt 1 inch thick.

The total expansion of the pipe line for the distance 1,466 feet is about 4 feet, assuming a variation of temperature of 350°. If the line is straight, this expansion could all be taken up in one

or two joints, providing an opportunity was given at the bearings where the pipe is supported for the creep produced by the expansion or contraction of the pipe to take place. We would not, however, advise an expansion joint, but would simply use a swing arm at the shaft and at the boilers; the arm being say 8 or 10 feet in length, and arranged so that it will swing upon the elbows and nipples of the steam pipe. This method of providing for the contraction of a steam line was explained very nicely in Prize Contest Question 649, page 456, MINES AND MINERALS, May, 1901. We would not advise burying the pipe.

J. T. B.

Shaft Sinking.

Editor Mines and Minerals:

SIR:—I wish the opinion of some of your readers upon the following points in shaft sinking: A finished shaft, which I am planning, will be 7 feet by 16 feet. There will be 45 feet of soil and quicksand and we expect to coffer dam this with boiler plate on the bottom so that it will cut in advance. There will be 125 feet of shale and sandrock and we expect to find a large volume of water in the sand rock. What strength of coffer dam will be required to resist the pressure at 170 feet below the surface. Reaching water at 70 feet below the surface in a drill hole, there would be 100 feet of pressure. Below the sandrock, we have about 60 feet of soapstone, shale and clay to the coal. Can we mine this 3-foot vein of coal longwall without danger of breaking roof to the overlying watery strata. We will need a full line of mine supplies.

IRVING MELLINGER.

Salem, Ohio.

The method of sinking proposed here by our correspondent is similar to that described upon page 139, MINES AND MINERALS, October, 1900. In this method an iron shoe or muff is constructed of boiler plate strongly riveted together and braced. This shoe forms a rectangular iron box having no bottom, the sides of the box overlapping the curbing or shaft lining, as shown in Fig. 4 of the article referred to above. As the material is excavated from the space within the area of the box, the latter sinks into the sand. The sides of this iron box or shoe, protect the excavation from the caving of the sandy strata, while the curbing is being added from below as the excavation progresses. This can hardly be termed sinking with a coffer dam, although it is probably the meaning intended. The thickness of curbing required when using white pine curbing, and assuming that the pressure of the water upon the curbing is that due to a head h , may be calculated by using the formula,

$$t = .016 s \sqrt{h},$$

in which t = thickness of curbing (in.);
 s = clear, unsupported span of curb timber (in.);
 h = head of water (ft.).

Thus, in this case for a head of 100 feet and for a clear unsupported span of 8 feet (assuming a line of buntings running up and down the center of the shaft) we have,

$$t = .016 \times 8 \times 12\sqrt{100} = \text{say } 15 \text{ in.}$$

If we assume that this is a three-compartment shaft having a pumpway 4 ft. $\times$ 7 ft., and two hoistways each 6 ft. $\times$ 7 ft., the unsupported span would then be somewhat less than 6 feet, according to the size of the buntings used, and the thickness of the curbing necessary to resist a head of 100 feet would then be 12 inches. In practice the pressure due to the full head of water is rarely realized and a less thickness of curbing is usually employed. If, however, a wedge curb is inserted below the watery strata, and made water-tight by cementing and packing, it would be necessary to use the full thickness of curbing.

In order to mine this 3-foot vein of coal, lying at a depth of 185 feet below the surface, and having about 60 feet of soapstone, shale, and clay immediately overlying the coal and separating it from the watery strata above, without breaking roof to the watery strata, probably the longwall system would be the best system to employ. Whether this could be accomplished, however, would depend upon the strength of the 60 feet of roof strata. If these roof strata are tough and yield gradually to the weight above, it is altogether possible to accomplish the desired result. If, however, the roof strata were brittle and contained faults, the mining of this seam without breaking to water would be difficult or wholly impossible to accomplish. In the latter case, some modification of the pillar and stall or panel systems would be preferable, in order that when water was encountered it could be shut off from other portions of the mine.

Efficiency of Fans.

Editor Mines and Minerals:

SIR:—I receive regularly a copy of your paper and from the nature of the business in which I am engaged I am greatly interested in some of the correspondence published therein, but I am at times puzzled to understand why there is such a great differ-

ence in the efficiency of fans used in mine ventilation and those used in other trades. I have frequently noticed in your answers to correspondents that you state that efficiencies as high as 80% can be obtained from mine fans or under average conditions of use 60% efficiency is considered fair. Now, in the steel plate fans even in sizes as large as 8 ft. and 10 ft. diameter of blast wheel we do not look for efficiencies under the very best conditions above 54% and even with a peripheral velocity of approximately 6,600 ft. per minute. The average efficiency of these fans used in heating or in general commercial use is something less than 50%. I do know that writers for some of the manufacturers claim results better than this and I also know that where the same manufacturers are held down to positive guarantees they do not venture more than I have stated above.

It has occurred to me that in the measurement of the efficiency of a mine fan that possibly I do not understand the exact conditions, and that in estimating the volume of air moved it is customary to multiply the area of the discharge or inlet of the fan by the total dynamic head against which the fan is working expressed in the equivalent of feet velocity per minute, and that no attempt is made to measure the actual quantity of air moved which would be dependent upon the velocity head rather than upon the total dynamic head, in other words, that no allowance is made for the loss in pressure and volume due to the frictional resistance of the mine. Am I correct in this? If I am not, will you please explain to me why fans used for this particular purpose attain such extraordinary efficiency?

Referring to the answer to question 648 in the May issue, will you kindly tell me why the Schiele scroll is preferred to the one obtained ordinarily from four points? Certainly none of the manufacturers of fans for other purposes use and prefer the Schiele scroll. Then again, it is customary to have a clearance space at the point of cut-off between the casing and the ends of the blades varying from 6 inches in the smaller sizes to 10 inches in the larger sizes, and the expansion invariably begins at that point rather than at a point further along equal to the space between two adjacent blades. We never experience any difficulty with noise with a pressure less than $1\frac{1}{4}$ inch *w. g.*, but above this point we find that all fans will make a noise. To overcome the pulsating effect and noise occasioned thereby, we find that adding to the number of blades will effect this.

Boston, Mass.

A. K. S. Fan Co.

The question of fan service is largely a question of conditions. The work any fan will perform is dependent not upon itself alone, but more particularly upon the conditions of its environment, and the question of efficiency is a very sensitive one.

To make this clear, suppose we design a fan for a service of 100,000 cubic feet of air under a water gauge of say 1 inch, at a speed of 75 revolutions per minute. This fan could not reasonably be expected to yield the same volume of air under an increased water gauge, except at a higher speed of rotation. On the other hand, at the same speed of rotation, the volume or yield of the fan may be increased or decreased by simply varying the resisting pressure. As the pressure is increased the volume is decreased and *vice versa*. But since volume and pressure (Qp) are component factors of power, the fact is pointed out quite plainly that assuming a constant efficiency of the fan, a constant power will produce a constant speed of rotation in a given fan, regardless

of the resisting conditions or the potential ($\sqrt[3]{q^2}$) of the circulation; but the yield of the fan is dependent upon the resisting conditions, and varies as the potential of the airway.

The writer does not state whether he refers particularly to the difference in manometrical or mechanical efficiencies of fans. The former is a ratio of effective and theoretical pressures, while the latter is the ratio of effective and theoretical powers. In this connection see article in this issue of MINES AND MINERALS, entitled "Manometrical Efficiency, What It Means", which explains the fact that manometrical efficiency relates to the efficiency of a single circulation and does not express the efficiency of the fan *per se*, which fact has been deplorably overlooked in our literature of the subject.

It is of no importance in the study of design to know what efficiency a machine presents under one condition only. In fan ventilation the same fan will not yield the same manometrical efficiency in two different circulations, which fact explains the numerous observed differences in this regard. The differences observed in mechanical efficiencies, however, arise from other causes. (1) There is a wide difference in mechanical efficiency due to the different types of construction. (2) Difference arises also in a different interpretation of the meaning of the term *efficiency*. It is sometimes understood as meaning the percentage of the power of the engine card that becomes effective upon the air; but as the engine possesses an efficiency of its own, it should

be our aim to separate these in determining the efficiency of a fan. (3) Another source of difference arises when the fan is working under conditions other than those for which it was designed. This is a very prolific source of trouble. An instance only recently came to our notice of a fan which should have shown an efficiency of at least 80 per cent., but under the conditions by which it was surrounded, the highest efficiency it developed was 36.6 per cent., which was not only a great disappointment to its owner, but a surprise and disappointment to the builder of the fan. The fact of this low efficiency, however, in no way reflected upon the type of construction. (4) Lastly, a difference in the observed efficiencies of fans of the same type of construction arises from the difference in the nature of the work they perform. This is a fact not always readily comprehended, but we realize its truth when we reflect that the fan as a ventilating motor not only furnishes a *generative volume*, but provides at the same time an *area of passage* for the circulation it creates. If these two factors, *volume* and *area*, were covariant, the relation of the fan to its circulation would be a constant relation. That is to say, the fan could be proportioned to any circulation without prejudice to its efficiency. This shows clearly that fans of the same type of construction cannot be expected to be equally efficient in all circulations. In other words, some circulations will cost more to maintain than others, in spite of equal efficiency of design in the motor. In regard to high efficiencies, 80 per cent. is not an extraordinary efficiency in fan ventilation. There are numerous well authenticated records of tests of fans showing 87, 88, and even 91.5 per cent. of mechanical efficiency. In estimating mechanical efficiency in mine fan ventilation, present practice divides the continued product of the sectional area of the airway (sq. ft.) and the observed velocity (ft. per min.), and pressure (lb. per sq. ft.) by the I. H. P. of the fan engine as computed from the engine card, multiplying the result by 100 to obtain percentage. The velocity due to the dynamic head ($v = \sqrt{2gh}$) is not used here; the velocity of the air current is measured with the anemometer, and the pressure by means of the water gauge. Efficiency in fan ventilation, as far as design is concerned, is very largely a matter of proportionment. In the humble opinion of the writer, the present blower practice as it relates to the construction of steel pressure blowers, does not conform to the theory of proportionment as closely as it should, and for this reason the efficiencies obtained are often relatively lower than those obtained in mine practice.

In regard to the form of the spiral casing referred to, the Schiele spiral, which is an evolute curve, is the most perfect that can be constructed. Much could be said in regard to the casing or housing of a fan. The earliest type of fan was the open running fan that had a free discharge into the atmosphere all around the circumference of the fan. Following this came the tight casing of the early Guibal fan, and a little later the expanded casing of the Schiele. At that time, however, there was no attempt at cutting off the air and causing it to travel around the fan, but the fan discharged its air into the closed space provided by the casing, and was conducted thereby to the chimney, losing much of its velocity before reaching the chimney. The later designs of mine ventilators provide a distinct cut-off, and by starting to expand the casing a distance behind this cut-off somewhat greater than the distance between two consecutive blade tips, cause the air to travel around the circumference of the fan in the direction of its revolution. This construction avoids any baffle or back-lash at the cut-off. If a tight casing is not provided at the cut-off, as just described, the pressure of the air at the blade tips will urge the current back toward the cut-off by the shortest route to the fan drift or chimney, thereby giving rise to conditions of pounding and vibration. In our experience there is not much difficulty in avoiding vibration or pounding with low pressures. Air travels in streams or layers that conform to the shape of the fan conduits, and it is the projection of these streams or layers of air under high pressures against each other, or against abutting surfaces, that gives rise to the vibration and pounding mentioned. The writer, as constructing engineer, has designed and erected numerous fans for various circulations, and was never troubled with vibration or pounding, and never employed a shutter such as is commonly used to overcome this difficulty. The increasing of the number of fan blades no doubt overcame the difficulty as mentioned, at the expense of a certain amount of efficiency in the machine.

J. T. BEARD.

The Alamo District, Lower California, Mexico.

By V. Wankowski.

The mineral possibilities of this peninsular having attracted considerable attention of late, this article will deal with the oldest camp in the northern portion, viz., Alamo.

A wild placer boom in 1888, succeeded by three years' phenomenal output, followed by a decade of idleness and abandonment, was, until 1899, the history of Alamo.

The Alamo district is situated seventy miles east of Ensenada, a port of entry and the capital of the northern district of Lower California, reached by steamer from San Diego, California, or an overland stage. A telephone system connects Alamo with Ensenada and the Western Union system. The altitude of Alamo is 4,000 feet, the climate being much the same as in Southern California. A good stage road permits quick traveling and reasonable freight rates, the trip from Ensenada occupying one and one-half days, and to Ensenada one day.

The mines are situate in the Alamo Basin, surrounded by four high mountain peaks, known as San Tomas, Alamo, Pinion Peak and Viznaga, the basin being about five miles long by three miles wide. The surrounding country is covered with a heavy growth of juniper wood, used for fuel and at a distance of twenty miles are the Pinerias, which furnish lumber and mining timbers. The Pinerias embraces an immense tract of heavy timber, covering the backbone of the peninsular; and the mountain system running north and south is the continuation of the San Bernardino and Sierras of California.

The principal properties were owned and worked ten years ago by the Princesa Gold Mining Co., Ltd., of London, which paid \$375,000 cash for the properties of the old Princesa Co., the Aurora Mining Co., and the Montezuma Co. These companies operated many claims in the district from which over \$750,000 was extracted above the 200 foot level. There were numerous individual operators in addition to the above companies and the Custom House at Ensenada shows an output from Alamo of over \$1,000,000, all taken from near the surface. A dike system prevails and the theory of the earlier work of the camp was that when the veins were cut by the dike, said veins were bottomed, which caused the abandonment of all work and the camp became deserted, excepting for a few placer miners and prospectors.

In 1899, the Sterling Mines, a Pittsburg company, acquired by purchase the entire holdings of the Princesa Co., and has since that time been at work on the various properties of the camp and has succeeded in demonstrating that the veins go down, proving a dike system which is regular in its irregularities and which does not fault the vein matter either in its dip or strike, and proving also that for a distance of nearly 6,000 feet upon the surface there are parallel veins, some ten in number, traversing the Alamo Basin. The dikes are antecedent to the veins and are about 500 feet apart on the surface, having a dip to the north and cutting the veins at an acute angle, making lenticular chutes of ore ranging from 50 feet in length near the surface, to 200 feet in length as disclosed by the lower workings. The formation of the walls and country rock is granite, with a schistose gouge separating the quartz from the walls in all the mines. The dike is diorite. The ore is free milling above water level, containing a heavier percentage of iron sulphurets and galena, with a trace of copper as depth is attained.

A cyanide plant for treating about 30 tons per day was installed last year and has been working on the tailings of the camp, which have shown a value of \$5.50 per ton. One pile of some 10,000 tons is being treated the second time for final extraction. Concentrators were installed and the metallurgical question has been proven, with the result that by a combination plant of battery amalgamation, concentration, and cyaniding, fully 90% of the gold values can be saved.

The mines furnish all water necessary for milling purposes. There are at present three stamp mills in the district, one of ten stamps and two of five stamps each, in addition to which there is a Wisewell roller mill.

A consolidation of the large interests in the camp has just been effected and a modern mill capable of handling 100 tons per day is to be erected in the near future.

The Faculty and Executive Committee of the School of Mines and Metallurgy of the University of Missouri located at Rolla, Mo., have issued a very neat invitation to the 30th anniversary of the founding of the school, May 30, 1901. Accompanying the invitation and tied to the upper left-hand corner is an interesting memento in the form of a lump of Missouri lead and an Anniversary medal made out of Missouri zinc.

The Legislature of Montana which recently adjourned, created the office of Inspector of Coal Mines, a much needed improvement in the mining administration of the State, as the mining industry of Montana is entirely too extensive to be watched over by a single inspector as has been the case heretofore. The qualifications for the Inspector of Coal Mines are that the person appointed must be a graduate of a reputable school of mines and shall have 10 years actual coal mining experience. Mr. Howard Welch, graduate of Columbia College, has been appointed to this newly created position.

Bituminous Statistics of Pennsylvania for 1900.

The following statistics for the bituminous coal mines of Pennsylvania are taken from the advance pages of the Report of the Bureau of Mines of Pennsylvania, courteously furnished by the Chief of the Bureau of Mines, Hon. James E. Roderick.

It has been known since early in the present year that the production of coal during 1900 was considerably in excess of the production during 1899. The figures furnished by the Department of Mines show an output of 79,318,362 tons during 1900, an increase of 8.5 per cent. over the output for 1899.

Although the output of coke during 1900 was slightly less than during 1899 (a decrease of 7,458 tons) the figures indicate an increased activity in oven building, as the report shows 4,604 more ovens at the close of 1900 than at the beginning. This activity in oven building extended over most of the bituminous area, but the section in which most new work was being done, both in opening up new mines and in oven building was undoubtedly in the new Klondike coal field, just west of the Connellsville field, a description of which was published in the April issue of MINES AND MINERALS.

A comparison between the statistics for the anthracite mines, as published in our May issue, and those for the bituminous mines here given will be of interest.

The highest number of days worked in any anthracite mine inspection district was 195 days, the lowest 154, and the average 171; while in the bituminous the highest was 261, the lowest 182, and the average 219.

In the anthracite region 143,828 persons were employed in producing 51,217,318 tons of coal, while in the bituminous only 109,018 employees were needed to produce 79,318,362 tons.

Again, in the anthracite region in producing only about two thirds as much coal as the bituminous, about four times as much black powder and fourteen times as much dynamite was used, or 1,237,180 kegs of powder against 296,367 kegs, and 3,454,641 pounds of dynamite as against 243,517 pounds.

At the anthracite collieries 4,880,932 tons of coal were used for fuel, and at the bituminous mines only 1,327,256; while the boiler capacity of the former was 349,450 H. P., and of the latter only 138,139 H. P. At the anthracite mines the total number of steam engines had a horsepower of 322,246, and at the bituminous mines only 94,309 H. P.

In regard to the motive power for hauling the coal the anthracite mines used 15,708 mules, 365 steam locomotives, 30 air locomotives, and 38 electric locomotives; while at the bituminous mines there were used 9,633 mules, 119 steam locomotives, 17 air locomotives, and 174 electric locomotives.

These comparative statistics answer in part the question so often asked as to why anthracite coal costs so much more than bituminous?

Precious Stones in the United States.

The precious stone industry of the United States during 1899 is summarized by Mr. Geo. F. Kunz in his report prepared for the U. S. Geological Survey as follows: "Among the principal items of interest relating to the production of gems in 1899 may be mentioned a general development of, and increased output from, the Yogo Valley sapphire mines in Fergus County, Montana, and the finding of a fine blue stone that afforded gems up to 4 carats in weight; also the discovery of remarkably brilliant sapphires—green, blue, pink, yellow, and brown—in many shades and tints, in Granite County, Mont.; the continued output of turquoise from the mines in Grant County, New Mexico; the reopening of the turquoise property near Santa Fe, New Mexico; the development of the turquoise localities in Nevada and California; a great advance in the price of emeralds and pearls; a decided increase in the price of all qualities of cut diamonds; a great increase in the amount of diamond cutting, especially of the finer qualities, in the United States, although this industry was materially affected because of the advance in prices during the latter part of the year; and, lastly, in general, a continued search for minor gems in North Carolina, Maine, Connecticut, and other States.

Total Number of Tons of Coal Mined and Tons of Coke Produced, Number of Days Worked, Number of Employees, Number of Persons Killed and Injured, Number of Kegs of Powder, Number of Horses and Mules, Boilers, Locomotives, Pumps, Dynamos, Air Compressors, Etc., Used in the Bituminous Districts for the Year Ending December 31, 1900.

Districts.	Shipments of Coal in Tons, by Rail or Otherwise.	Number of Tons Used for Steam and Heat at Collieries.	Number of Tons Sold to Local Trade and Used by Employees.	Total Production of Coal in Tons.	Total Production of Coke in Tons.	Number of Coke Ovens.	Average Number of Days Worked.	Number of Persons Employed.	Number of Fatal Accidents.	Number of Non-Fatal Accidents.	Number of Kegs of Powder Used.	Number Pounds of Dynamite Used.
First.....	8,542,165	87,962	24,154	8,654,281	.....	.....	182	10,942	38	144	34,302	6,875
Second.....	6,912,243	247,477	161,137	13,644,199	4,280,354	9,462	248	17,552	56	56	4,070	10,725
Third.....	4,820,945	51,967	50,965	4,928,877	95,501	408	221	7,650	6	58	17,228	9,681
Fourth.....	7,138,760	192,975	51,814	8,199,027	480,674	1,529	236	10,388	21	60	38,546	48,314
Fifth.....	2,831,875	178,568	82,110	9,960,273	4,477,692	11,292	254	18,867	40	56	34,499	62,924
Sixth.....	10,067,978	184,579	85,812	10,694,627	256,481	787	215	14,879	30	38	72,569	56,319
Seventh.....	6,485,977	286,511	211,088	6,938,576	.....	.....	185	10,045	23	72	21,096	1,950
Eighth.....	4,225,981	57,864	18,678	4,842,176	20,724	50	181	7,330	9	27	25,628	18,078
Ninth.....	3,888,262	112,558	69,962	7,571,754	2,241,158	5,846	261	8,969	21	38	28,058	9,361
Tenth.....	8,650,818	80,280	23,011	4,890,572	832,583	1,251	205	7,401	21	50	25,275	19,790
Totals for 1900.....	58,564,954	1,327,256	723,731	79,318,362	12,185,112	30,120	219	109,018	265	584	296,367	243,517
Totals for 1899.....	58,376,096	823,415	630,801	73,066,943	12,192,570	25,516	296	91,571	258	497	258,428	222,076

Districts.	Number of Horses and Mules in Use.	Number of Boilers.				Total Horsepower.	Locomotives.			Number of Steam Engines of All Classes.	Total Horsepower.	Number of Pumps Delivering Water to Surface.	Capacity in Gallons per Minute.	Quantity in Gallons Delivered to Surface per Minute.	Number of Electric Dynamos.	Number of Air Compressors.
		Cylindrical.	Horsepower.	Tubular.	Horsepower.		Steam.	Air.	Electric.							
First.....	823	65	2,772	114	11,876	15,173	1	2	16	111	1,682	58	12,454	7,239	82	10
Second.....	1,480	117	3,491	197	13,334	20,685	36	5	6	230	19,357	102	59,529	24,062	16	29
Third.....	604	29	1,545	84	7,370	8,915	5	.....	4	79	5,027	45	8,051	4,786	4	24
Fourth.....	998	14	725	135	14,100	14,925	22	3	18	78	7,417	42	38,080	7,591	12	31
Fifth.....	1,519	83	4,636	195	16,671	20,857	28	3	3	157	18,435	92	28,005	16,671	21	81
Sixth.....	1,167	62	8,965	123	11,685	20,630	3	3	65	124	14,707	37	17,313	9,950	42	52
Seventh.....	744	51	2,633	111	11,870	14,503	5	.....	26	128	11,709	70	9,741	6,800	31	24
Eighth.....	769	29	1,985	61	4,843	6,568	1	.....	16	44	3,140	54	20,911	6,885	10	9
Ninth.....	893	87	3,059	96	8,184	11,243	14	1	12	128	9,777	48	13,747	8,107	24	11
Tenth.....	636	24	900	46	3,720	4,620	4	.....	8	45	3,058	27	9,812	5,302	5	5
Totals for 1900.....	9,633	561	30,711	1,162	103,653	138,139	119	17	174	1,124	94,309	575	217,643	96,693	196	225
Totals for 1899.....	8,013	539	28,802	968	70,735	104,419	110	13	122	1,043	70,651	520	198,835	108,067	156	160

KELLY AND NEWHOUSE TUNNELS.

The Sources from Which Such Tunnels Derive Revenue—How They Are Planned and the Methods Used in Driving Them.

Written for MINES AND MINERALS, by Prof. Arthur Lakes.

In a previous article in MINES AND MINERALS we have alluded to some of the advantages a long crosscut tunnel scheme may be to certain districts. It is not to be supposed, however, that these are mere philanthropic schemes for the relief and benefit of the water-belated mines of that district—far from it. There are "tunnels and tunnels." There are "wild-cat" tunnel schemes as there are "wild-cat" mining schemes. There are also tunnel schemes which are started after careful examination, and deliberation and calculation, as legitimate enterprises, with a reasonable expectation of making the tunnels an ultimate financial success to the shareholders, as well as a boon to the neighborhood in which they are started.

The sources of revenue, as commonly stated in the prospectus of such undertakings, are: royalties from transportation of ores, waste rock, etc., as also a certain payment for unwatering water-logged mines, hauling in timbers, supplies, men in and out, and furnishing power and light. If a vein or mine shaft was cut and relieved of its water by the tunnel, and the owners should fail to pay for the privilege of unwatering it, or refuse to accept the advantages of the tunnel in this respect, the owners of the tunnel could close up or bulkhead off the opening into the tunnel from

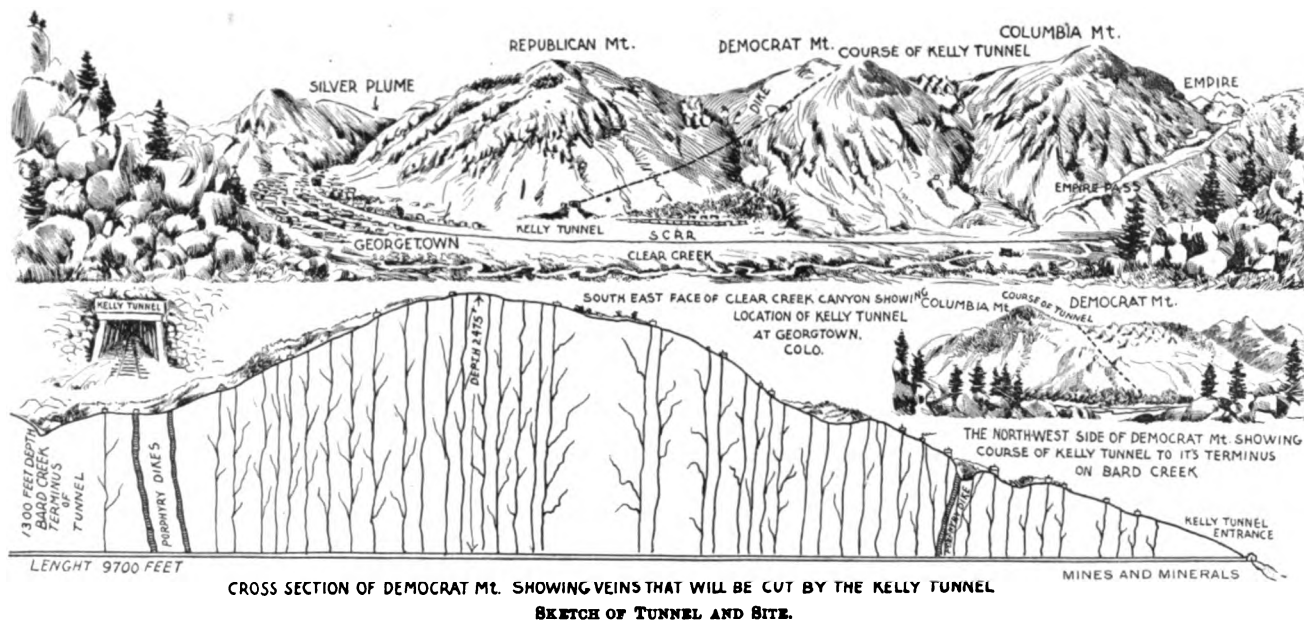
Against these sources of revenue to be considered is the cost of driving the tunnel. This, besides actual driving, involves at first the expenses of a plant to work drills, supply air or electricity, and to maintain the same.

We understand that the great Newhouse Tunnel, which is 12 ft. $\times$ 12 ft., cost for the first mile, an average of \$20 per foot.

The Kelly Tunnel, of average size 8 ft. $\times$ 8 ft. in the clear is to be driven at the rate of \$15 per foot, or about \$37,500 for the first 2,500 feet. The rate of progress, barring unforeseen delays or accidents, will be from about 200 to 300 feet per month, air or electric drills being used.

In the Newhouse Tunnel, according to a recent account, they made 220 feet in December, 1900, but expect to improve on that in the future. Three air drills are being worked at the breast, one round of holes being put in daily. Another party is drifting west from the tunnel on the Gem vein, cut a short time ago by the Newhouse; the ore streak is several feet wide, and as soon as stopping ground is opened they will commence mining the ore above. Other companies from the surface are pushing down work to connect with the tunnel below. The Aduddle, Morning Star, Aurora, and other large master veins of the region are being vigorously worked from the surface, as their veins are expected to be cut by the tunnel before the year 1901 is ended.

All this goes to show what we mentioned in a previous article that in these long crosscut tunnel schemes as soon as a veiny section is entered on by the tunnel, work is begun on the veins cut, both from the surface and within the tunnel itself, without waiting for the final completion of the tunnel.



CROSS SECTION OF DEMOCRAT MT. SHOWING VEINS THAT WILL BE CUT BY THE KELLY TUNNEL
SKETCH OF TUNNEL AND SITE.

the mine and bid them keep their water if they wanted to; the same might apply to transportation of waste rock and even ore, but few mines would be so foolish as to refuse the assistance of the tunnel if the terms of agreement were made reasonable on both sides. A second source of revenue is that of operating, under a system of lease, veins of mines struck which are already located and worked on the surface.

In some cases a company projecting a long crosscut tunnel endeavors to acquire outright, on the lowest terms, veins or mines shown on the surface with ownership of 1,500 feet on all lodes discovered, this is a third source of revenue.

The fourth is the acquiring sole ownership by right of discovery of "blind" but valuable lodes below the surface. In the course of such tunnels there are likely to be considerable areas which on the surface, by reason of drift or forest covering, show no outcropping veins and therefore have not been taken up to any great extent by surface prospectors. Undoubtedly those blank areas contain veins, it may be, as rich as any discovered. While the tunnel company may claim all veins it may find in the tunnel beneath such surface areas, yet to avoid conflict and contention, it is the policy of such a company, if possible, to secure on the surface all such apparently barren areas.

Lastly, profits derived from milling and concentrating ores that come out from the tunnel. The tunnel company will in due time erect its mills near the entrance of the tunnel and will have a practical monopoly in milling all the ores of all the veins or mines struck by the tunnel. These are the principal sources of revenue to which the tunnel companies generally look.

As preliminary work before opening the tunnel or making up its prospectus, a surveyor and mining engineer, preferably, if possible, one locally acquainted with the neighborhood, goes over the ground, establishes the horizontal linear course of the tunnel, takes the various points of elevation of the mountain, and the elevation and depth of all the mines opened from the surface, from this he constructs an ideal section of the mountain, as shown in the accompanying sketch, locating on it all known veins, their depth from the surface to the tunnel, and the horizontal distance from the tunnel mouth at which each will be encountered. In doing this he makes due allowance for the degree of dip of the veins, which in Clear Creek County is apt to be very steep and often but little deviating from verticality.

Photographs may be taken at various points on the mountain showing the surface appearance and contour of the ground, as well as the surface mine workings met with along the course of the tunnel. From these, or similar points, a panoramic view, or sketch, may be made like that in our illustration, showing the natural surface appearance of the country traversed beneath the tunnel. A still more forcible way of presenting this to the public is by having a large plaster model of the mountain made from sketches, photos, and other observations, and by a section through it showing all the veins that will be cut by the tunnel.

The next task is a formidable one, viz., to endeavor to obtain, as nearly as possible, a reliable account or estimate of what the mines and veins along the course of the tunnel have produced in past time. This is often particularly difficult because many of these mines, from water, or other obstructions, have long ceased

to be worked. Hearsay reports are excessively unreliable, almost sure to be exaggerated, and mine records, as well as mill records are apt in a decade to be lost, or destroyed by fire or other accidents; however, by careful and laborious work, sufficiently reliable mill tests and records, are generally to be found in an old district, enough to obtain a fair average account of what in the past that district, as a whole, has produced, and what under the tunnel scheme, and with modern improvements, it is likely to produce, being well satisfied from geological reasons that the veins continue down permanently with depth.

Taking the Kelly Tunnel, at Georgetown, as an example. The granite mountains rise upwards of 2,500 feet at their highest point above the level of Clear Creek and its cañons. The Kelly Tunnel is projected through Democrat Mountain to Bard Creek for a distance of about 2 miles. Its greatest depth under the summit of Democrat Mountain will be 2,500 feet, and at its terminus on the opposite side, under Bard Creek, the depth will be 1,300 feet. Few of the mines so far worked have gone below 500 feet, so that the average depth of the tunnel on the veins will be between 1,000 and 2,000 feet. We may here observe that excessive depth is not to be desired because it may take so long for the mines from the surface to reach the tunnel below. Upwards of 40 well-known lodes will be cut in the course of the tunnel besides, no doubt, many blind veins hitherto unknown. The depth at which these veins (upon many of which are old producing mines) will be cut will vary from 240 to 2,475 feet, 1,000 feet being the average. The course of these veins in granite is east and west, and northeast and southwest, and the dip of most of them deviates very little from a vertical, as we have represented them on the section. Their width is from 2 to 12 feet.

They contain silver-lead ores, and in most cases the silver values are very high grade. The lead also is of high grade. In nearly all the mines there are bodies of compact smelting ore and a margin of concentrating ore. There appear to be two zones in the mountain along the course of the tunnel that are principally mineralized and veiny. A zone, with many veins crossing it, some 3,000 feet in length from the entrance of the tunnel is characterized by a preponderance of lead qualities and quantities over silver. Then follows a zone of nearly 2,000 feet in length, whose many veins and values are at present unknown, but which will doubtless contain so-called blind veins. This is marked blank on the section. This is followed by the richest and most worked zone of the mountain beginning near the summit, and extending west down to the terminus of the tunnel on Bard Creek. This contains some 18 to 20 well-known, large, and parallel veins, characterized by bodies of high-grade silver ores associated at times with such high-grade silver-bearing minerals as polybasite and gray copper; whilst the lead bodies and values are less than in the zone on the southeast in Clear Creek Cañon. It was from this zone that the main silver riches of Georgetown originally came. These mines being worked near or at the summit of the precipitous mountain, were at great disadvantage, as every pound of ore had to be carried down the mountain on donkey back. Moreover, at a depth of less than 500 feet, large bodies of water were encountered, and most of the mines were unable to compete with it. Some short crosscut tunnels were projected, but these only relieved the mines to a depth of 300 to 500 feet. Ore that would be considered quite high grade now, or at least medium grade, was thrown on the dump, and only the choicest and richest sent down to the crude mills in the valley, or to the smelting works at Denver, by a 50-mile wagon road. Treatment and exportation of such ore cost in those days, it is said, from \$30 to \$45 per ton. It is obvious that only the highest grade would pay. All these local disadvantages will be done away with by the completion of the Kelly Tunnel. The mines will be unwatered and their ores and waste rock transported through the tunnel, whilst concentrating works at the mouth of the tunnel will treat their ores at the lowest possible rate, or their smelting ore can be quickly shipped to the Denver smelters. What the tunnel, combined with the improved modern state of things, may do with the mines of this old camp cannot be duly estimated, but it will be a vast improvement over the past we can be well assured. There are many valuable veins and mines in the same mountains which are not directly in the line of the tunnel, these may eventually be reached by laterals extending from the tunnel and so a large mining area be brought within the influence of the tunnel.

As regards water, the whole section drained by a tunnel will soon feel the influence of a main artery like the tunnel; not merely the mines or veins directly on its course, but others far off it. The Newhouse Tunnel had not far progressed before a sensible diminution was perceived in some of the deep mines that were a considerable distance from the tunnel. At Central, many mines are now remarkably dry. Their dryness is attributed to the influence in the neighborhood of the Bobtail Tunnel though quite off its line. A great artery tunnel or excavation in a mountain

seems insensibly to attract all the water towards it, nature apparently hating a "vacuum."

As regards the equipment of these tunnels. The Kelly Tunnel will be 5 feet in the clear with a double track of 18-inch gauge, laid with 25-pound rails, and an up grade into the mountain of 8 inches in 100 feet. Running along the center of the tunnel will be a long box or covered drain, 12 in. $\times$ 20 in. which will convey the drainage water and assist to a certain extent in ventilating the mine. Compressed air and electric drills will be used, electricity to be conveyed to the mines from the electric works of Georgetown, close by.

In mines of all kinds, but especially in these large tunnel schemes, care must be taken to secure ample dumpage ground, as the output from a tunnel 2 to 4 miles long soon builds up a large dump covering several acres and many feet in height. Accordingly, such tunnels must be driven at a moderate height above the level of the valley, and must secure, either by purchase or other ways, several acres or city lots for dump. In some mining towns like Butte, Montana, the dumpage of mines seriously encroaches on the dwellings of the town, and expensive city lots have to be purchased for dumpage privileges alone. It is especially advisable to secure such ground for dumpage and mills before a growing town encroaches on the mining area. At the Kelly Tunnel, in Georgetown, as well as the Newhouse, at Idaho Springs, ample acreage has been secured for dumpage ground and erection of mills. These mills will practically have the monopoly of the ores of most of the mines along the course of the tunnel, as being at the tunnel mouth the ore will be run directly by gravity into the hoppers and receiving bins on top of the mill. A switch from the railroad, of course, will run close to the tunnel entrance.

The Newhouse Tunnel is 12 ft. $\times$ 12 ft. with double track of 18-inch gauge and with a space of 30 inches between tracks. Beneath is a wooden drain 2 feet wide and 14 inches deep, the top of the drain even with the top of the ties forming a footpath. This drain for a while sufficed to carry out the foul air assisted by an exhaust fan when the flow of water was slight. Now the foul air is carried out through the medium of a No. 7 Root exhaust fan located in the engine house at the outlet, with capacity of 12,000 cubic feet per minute, and connected with the breast of the tunnel by a 19-inch steel air pipe.

The first 80 feet or so in both the Kelly and Newhouse tunnels are timbered with 12-inch squared timber; for the rest of the way the rock is so firm that very little timber is required only at intervals, when veins are intersected. The rails of the Newhouse weigh 30 pounds per yard and are laid on ties $7\frac{1}{2}$ feet long, which on one side are laid with the end close to the rail to allow room for an open side drain. The Newhouse grade is 5 inches in 100 feet into the mountain.

In the Newhouse, several dikes of porphyry have been cut. The Kelly Tunnel will meet with the same experience. In some respects the Kelly Tunnel has an advantage over the Newhouse in that it will cut some productive veins within the first 2,000 feet, and will not have to wait until it has gone a mile, as will the Newhouse.

The straight line of the tunnel is maintained by a surveyor who has wooden plugs with screw eyes driven in the exact center line of the roof. By alignment with lamps suspended from these points the exact center is determined in the heading every day. The workmen at the face have thus a vertical central line down the heading and commence work on either side of this.

The drilling is by 3-inch cylinder Leyner power drills. Holes at the time of our visit were 19 in number, drilled 5 on either side of the central line and 4 or 5 nearer the sides of the tunnel. The first holes converge inward, and the central core is blasted out, first taking out a wedge-shaped mass of rock. The center cut holes are 8 to 10 feet deep, the side ones 6 to 8. Dynamite is used, from 100 to 175 pounds each round. The charge is fired by an electric battery located safely in a short crosscut some distance from the face. 21 men were at the time employed, divided into one shift of drill men and two shifts for handling rock.

The power house of the Newhouse contains of two 16 in. $\times$ 16 in. Norwalk air compressors, three 80-horsepower boilers, a No. 7 Root exhauster with capacity of 12,000 cubic feet per minute, as described above; the exhauster has a 50 H. P. direct-connected engine either for blowing or exhausting air by valve switches in the pipe. The fan blades of the exhaust weigh 9,000 pounds.

The following amongst other legal points abbreviated from the Statutes and decisions of the United States on tunnel rights, are pertinent to the subject of this article.

No. 2323. Where a tunnel is run to develop a vein or lode or to discover mines, the owners of such tunnel shall have right of possession of all veins or lodes within 3,000 feet from the face of such tunnel on the line thereof, not previously known to exist, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface, made by other parties after

the commencement of the tunnel, and while the same is being prosecuted shall be invalid; but failure to prosecute the work of the tunnel for 6 months shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel.

No. 3140. If any person shall locate a tunnel claim for the purpose of discovery, he shall record the same, specifying the places of commencement and termination thereof with names of parties interested therein.

No. 3141. Persons working tunnel shall be entitled to 250 feet each way from said tunnel on each lode so discovered, provided they do not interfere with any vested rights. If it appears that claims have been staked off and recorded prior to the record of said tunnel on the line thereof so that the required number of feet cannot be taken near said tunnel they may be taken upon any part thereof where the same may be found vacant and persons working said tunnel shall have the right of way through all lodes lying on its course.

Mining Statistics for the United Kingdom During 1899.

The following statistics of the mining industry of Great Britain and Ireland are taken from the report of Mr. C. Le Neve Foster, issued under date of May 8, 1900.

The total number of persons employed in and about all the mines of the United Kingdom was 764,166, of whom 729,009 worked at the 3,216 mines under the Coal Mines Act, and 35,157 at the 794 mines under the Metalliferous Mines Act.

Compared with 1898 there is an increase of 22,115 persons at the mines under the Coal Mines Act, and of 926 persons at the mines under the Metalliferous Mines Act. The increase in the number of persons employed at mines under the Coal Mines Act is nearly double what it was in 1898.

Of the 729,009 persons working at the mines under the Coal Mines Act, 583,009, or about 80 per cent., were employed below ground. Of the 146,000 surface workers, 4,702, or 3.2 per cent., were females. There is an increase of 85 females compared with 1898. At the mines under the Metalliferous Mines Act, 20,618 persons or nearly 59 per cent., worked below ground, and of the 14,539 surface workers, 459, or nearly 3.2 per cent., were females.

At the quarries under the Quarries Act there were 97,995 persons employed, of whom 64,159 worked inside the actual pits or excavations, and 33,836 outside.

Compared with 1898 the figure of persons employed outside quarries shows a reduction of 37,890 persons employed; but it is important to point out that this reduction is apparent, not real. It is due to the transfer of the duty of inspecting the works for making bricks, tiles, Portland cement, etc., situated outside the quarries, from the Mines Branch of the Home Office to the Factory Branch. So far as the inside workers are concerned, the figures show an increase of 1,407 persons, and no doubt at the outside works there is in reality a corresponding larger number of persons employed. The persons employed occasionally at quarries are not included in the above figures.

The total output of minerals at the mines under the Coal Mines Act was 233,319,084 tons, of which 220,085,368 were coal, 2,931,091 fireclay, 7,775,868 ironstone, 2,210,824 oil shale, and 315,933 sundry minerals. Adding 9,413 tons from open quarries, the total output of coal was 220,094,781 tons, which is higher than that of the previous year by 18,040,265 tons. The total output of minerals at the mines under the Metalliferous Mines Act was 3,672,841 tons, of which 1,955,796 tons were iron ore. The total quantity of stone and other minerals obtained from the quarries under the Quarries Act was 43,451,973 tons, of which 3,408,755 tons were iron ore. Adding to the product of mines and of quarries over 20 feet deep, 1,320,911 tons obtained from shallow open workings, we arrive at a total output of iron ore of 14,461,330 tons.

At the coal mines there were 868 separate fatal accidents, causing 916 deaths. Compared with 1898 there is an increase of 40 in the number of accidents, and an increase of 8 in the number of deaths. At the metal mines there were 47 fatal accidents, which caused 56 deaths. Compared with 1898 there is an increase of 16 in the number of accidents and of 23 in the deaths.

At the quarries there were 117 fatal accidents, which resulted in 117 deaths. Compared with 1898 there is a decrease of 14 in the number of accidents, and a decrease of 17 in the number of deaths. The diminution in the number of deaths notified is partly due to the transfer of many of the outside works to the Factory Branch, as previously mentioned.

The number of non-fatal accidents reported during the year amounted to 3,904 at coal mines, 341 at metal mines, and 1,126 at quarries. As the statutory standard of severity governing the notification of non-fatal accidents is not always interpreted by the managers in the same manner, no stress should be laid on these figures, excepting as regards injuries caused by explosions of firedamp, explosives, and steam boilers; in these three cases

notifications have to be sent to the Inspector, no matter how slight the injuries.

The death rate of the underground workers at the coal mines was the same as that of the year 1898, viz., 1.37 per 1,000 persons employed, whilst that of the surface workers was .79 per 1,000 employed, as against .92 for the previous year. The death rate of the underground and surface workers as a whole was 1.26 whilst that of 1898 was 1.28.

At the metal mines the death rate of the underground workers was 2.43 per 1,000 persons employed, and of the surface workers .41 per 1,000. The corresponding figures for 1898 were 1.34 and .43 respectively. The death rate of the underground and surface workers as a whole was 1.50, a figure decidedly higher than that of 1898, which was only .96.

At the quarries the death rate from accidents of the workers inside the actual pits or excavations was 1.53 per 1,000, and of the persons employed at factories and workshops outside the quarries, but connected with them, .56 per 1,000. The corresponding figures for 1898 were 1.59 and .47, respectively. The death rate of the inside and outside workers as a whole was 1.19 in 1899, as against 1.00 in the previous year.

The apparent increase in the general death rate of the quarry workers is due to the transfer to the Factory Branch of a large number of workers outside the quarries, who are subject to small risks. The inclusion of these workers in former years lessened the average death rate of total number of persons employed inside and outside. As appears above, the quarries proper, or inside workers, had a slightly smaller death rate from accidents in 1899 than they had in the previous year.

Mark Twain on Mines.

So many stories are now afloat in the daily press about lost mines, and wonderful new discoveries, that it may not be out of place to reprint some remarks of Mark Twain on the subject of rich gold deposits, which originally appeared forty odd years ago in the California paper he was connected with:

"I have just seen your dispatch from San Francisco in Saturday evenings Post," wrote Mark, "about gold in solution in Calistoga Springs, and about the proprietor having extracted 1,600 ounces of gold of the utmost fineness from two barrels of water during the past fortnight, by a process known only to himself. This will surprise many of your readers, but it does not surprise me, for I once owned these springs myself. What does surprise me, however, is the falling off in richness of the water. In my time the yield was a dollar a dipperful. I am not saying this to injure the property in case a sale is contemplated. I am saying it in the interest of history. It may be that the hotel proprietor's process is an inferior one. Yes, that may be the fault. Mine was to take my uncle (I had an extra one at that time on account of his parents dying and leaving him on my hands) and fill him up and let him stand fifteen minutes to give the water a chance to settle. Well, then I inserted him in an exhaust receiver, which had the effect of sucking gold out through his pores. I have taken more than \$11,000 out of that old man in less than a day and a half.

"I should have held on to those springs, but for the badness of the roads and the difficulty of getting the gold to market. I consider that the gold-yielding water is in many respects remarkable, and yet no more remarkable than the gold-bearing air of Catgut cañon up there toward the head of the auriferous range. This air, or this wind, for it is a kind of a trade wind which blows steadily down through six hundred miles of the richest quartz croppings during an hour and a quarter every day, except Sundays, is heavily charged with exquisitely fine, impalpable gold. Nothing precipitates and solidifies this gold so readily as contact with human flesh heated by passion. The time that William Abrahams was disappointed in love he used to sit out doors when the wind was blowing, and came in again and began to sigh, and I would extract over a dollar and a half out of every sigh. He sighed right along, and the time that John Harbinson and Aleck Norton quarreled about Harbinson's dog, they stood there swearing at each other; and they knew how, and what they didn't know about swearing they couldn't learn from you and me, not by a good deal; and at the end of every three or four minutes they had to stop and declare a dividend. If they didn't their jaws would clog up so they couldn't get big, nine-syllable ones out at all, and when the wind was done blowing they cleaned up just a little over \$1,600 apiece. I know these facts to be absolutely true, because I got them from a man whose mother I knew personally. I do not suppose a person could buy the water privilege at Calistoga now at any price, but several good locations along the course of the Catgut cañon gold-bearing trade winds are for sale. They are going to be stocked for the New York market. They will sell, too; people will swarm for them as thick as Hancock veterans in the South.

"MARK TWAIN."

THE STINE FAN.

A Description of a Type of Mine Fan which has Given Good Results in the Bituminous Regions of Pennsylvania.

The Stine mine fan was first placed upon the market by the "Stines" in 1895 and, with the exception of a few mechanical changes and no change in the form of blades or vanes, the very first fan manufactured gave results beyond the most sanguine expectations of the makers. The officials of the Berwind-White Coal Mining Co., were so well pleased with this first installation that they invited a committee of experts to make a test of this fan which was located at Eureka No. 13, at Smoke Run, Pa., in what is known as the "Clearfield" basin.

The coal at this place is very thin, scarcely averaging over 2 ft. 6 in. in thickness making the ventilation of the mine rather difficult, owing to the necessarily small airways; yet this fan, which was only 7 feet in diameter, as shown by several tests gave 76,000 feet of air with 0.75 inch water gauge at a speed of 276 revolutions per minute. Afterward, Mr. H. M. Blyth, then in charge of the mine, kept a record of what the fan and engine were doing under ordinary working conditions, with a view not of making a test as to frictional losses, etc., but rather to determine just what the fan, engine, and boiler were doing under the conditions that actually existed at the mine during the time work was being done. Mr. Blyth writes as follows:

"I made a very strict test of the fan for five hours. At 8:30 o'clock A. M. the anemometer registered 51,060 cubic feet of air per minute with 258 revolutions of the fan, and at 1.30 P. M. I got 49,580 feet of air with 232 revolutions of fan, and in the five hours which we ran the fan, at one speed as nearly as possible, we burned exactly 245 pounds of coal, making 490 pounds of coal for 50,000 cubic feet of air per minute in ten hours. This was done as accurately as it could possibly be done, as we were very particular.

"I may also state the measurement of air course is 3 ft. x 6 ft. 2 in., making an area of 37 square feet and the average distance the air traveled was about 1½ miles."

This test was made a considerable time after the one previously mentioned, and as these tests were so very favorable, the Berwind-White Coal Mining Co. afterward placed orders for several more of this type of fans of various sizes with Messrs. Stine & Son, three of them being located in the Windber Mines, two in the Punxsutawny district and the balance in the Clearfield region.

The makers of this fan have in a number of instances taken out other types of fans which had proven too small or inefficient and substituted the Stine fan of equal size, under a positive guarantee that it would move from two to three times as much air as the fan then in use, and in no case has one of the fans failed to do the expected work. This is best illustrated by an example of an actual case. In one of the prominent mines in Pennsylvania a 12-foot Guibal type of fan was used. As the resistance became greater the fan would not produce a sufficient quantity of air, the maximum being 37,000 cubic feet per minute. After an examination of the conditions, Mr. Stine agreed to replace this fan with a 12-ft. fan of his own construction, guaranteeing 100,000 cubic feet of air, which guarantee was entirely fulfilled, and, although owing to a daily output of about 1,500 tons per day, the resistance has steadily increased, this fan for the past four years has given every satisfaction and the same firm has placed an order for a second fan for a new opening.

As the Stine fans run at comparatively high speeds they are especially desirable where the conditions are such as to make the employment of electric, gasoline or other high-speed motors preferable, as they may be belted or connected direct, dispensing with costly high frictional reduction gearing.

The fan shaft and bearings are constantly lubricated from a well in the bottom of the boxes, the lubricant being delivered to the shaft continuously with ring oiling devices such as are generally used by the makers of the better class of electric machinery. Oil is only required about once a week, and the fan can, if so

desired, be started at the source of power and absolutely no attention, beyond an occasional oiling, need be given any part of the machinery. This same feature makes this fan extremely valuable where it becomes necessary to use an auxiliary fan inside as a help to the fan located on the surface.

While it cannot be claimed that the practice of locating a fan inside a mine is economical or efficient yet there are cases, especially where no explosive gases are encountered, that it becomes highly desirable to do so.

As to what has actually been accomplished in this direction we can do no better than cite a case where the distance the air traveled had become so great that "drag" necessitated a change at once as the fan in the air shaft was incapable of delivering but a small quantity of air at the face of the headings. A large ventilator was first talked of but the time required to build same was such as to render it out of the question. As the mine was equipped with electricity it was decided to place a 7-foot Stine fan at the face or a reasonable distance from it, driving the fan with an 8 H. P. motor, this was done at very little expense and the volume of air so increased that the idea of a larger fan has been abandoned for quite a while to come, at least. Illustrations of this kind might be given of many other plants where it has been found advantageous to use the fan but lack of space forbids.

Another valuable feature of this fan is its compactness and the ease with which it can be erected. The buildings may be of the very cheapest kind, in fact all the building necessary is for protection against the elements and sufficient material to connect it to the air shaft.

The fan can be used either as an "exhaust" or "blower" without the use of a single door and can be changed from one to the other in a moment's time.

This fan has been very carefully designed and so large is the factor of safety which has been used that although there are hundreds of the fans in successful operation the makers claim that there has never been a breakage of the most minute character, nor, as far as the writer knows, has a single cent been expended on one of them for repairs.

The subjoined cut shows the principal features of the fan very clearly: the outside casing is made of the best steel, while the vanes or blades are of the best quality of flange steel, securely braced to an auxiliary hub. The shaft is of best hammered steel and the hub or center is one solid casting of best gray iron and keyed to the shaft. The hub is drilled from the solid and reamed out to the exact size for the reception of the vanes, which have a tapered sleeve riveted to them, making a perfect fit with large frictional contact. After fitting up the sleeves all are inserted in the hub and tapered keys fitted so as to prevent absolutely any possible chance of the blades or vanes becoming detached from the hub.

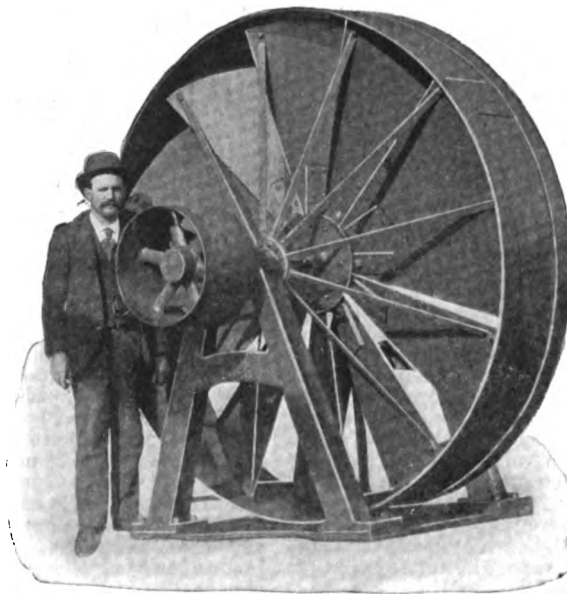
The construction of the entire fan is such that no single piece occupies much space and it can be "knocked down" and be transported with the positive assurance that each piece will fit perfectly when it is reassembled. The makers claim this fan will move more air for less money than any other fan in the world and that it has met with a hearty reception in every mining district where it has been introduced. The manufacturers are S. B. Stine & Son, Osceola Mills, Pa., who will cheerfully furnish such data as may be desired by prospective purchasers.

According to the Canadian Correspondent of the Colliery Guardian, London, the principal collieries in Nova Scotia, with their production during 1900, were the following:

Dominion Coal Co.	1,834,680	+281,124
Cumberland Coal Co.	896,783	+47,068
Acadia Coal Co.	252,807	+19,134
Intercolonial Coal Co.	217,440	+25,817
Nova Scotia Steel Co.	217,428	-8,942
Canada Coal Co.	63,500	-2,500
Sundry	31,000	+9,000

Total production, 1900 3,013,638 (+375,701 net increase)

This output is less than was expected, but owing to the labor and other difficulties, the expected output was not realized. The output for 1901 is estimated at 4,000,000 tons.



A STINE FAN.

Practical Mining Studies

"Practice yourself on little things, and then proceed to greater."

Why Short Circuits Cause Damage.

Every station man knows what elaborate precautions are taken on switchboards in electric light and power stations to prevent damage from short circuits. There is practically only one style of switchboard on which these precautions are not taken, and that is an arc-light switchboard. The reasons why protective devices are not necessary in this case will appear later. The damage due to short circuits is usually guarded against by connecting fuses or circuit-breakers in the line so that the dynamo will be disconnected when trouble arises.

Let us first see just what is meant by a short circuit; we will then be in better shape to study its effects. In brief, a short circuit is a connection that becomes accidentally established so as to give a path of very low resistance for the current. For example, take the case in Fig. 1, where we have a dynamo *A* supplying current to a mine locomotive *B* by means of the feeder *F*, trolley wire *c*, and the track *d*. Under ordinary circumstances the current flows out from the dynamo over the wire *c*, down through the locomotive and back by way of the track. So long as everything is working properly, the locomotive offers considerable resistance to the flow of the current and there is no trouble; but suppose a wire *x* falls across the trolley wire and down on to the track. This connection allows current to flow directly from the trolley wire to the track, and the path so established is one of low resistance. It is therefore known as a short circuit.

A short circuit always carries with it the idea of a short, low resistance path. If the path is of high resistance, it does not give rise to any serious trouble and is simply a leak which allows a certain amount of current to leak from one line to the other or from the lines to ground. For example, wires running through trees are often connected together through the wet branches, but such connections do not give rise to the violent demonstrations of a short circuit, simply because their resistance is high. Of course even a connection of this kind might give trouble if the pressure between the lines were very high, as it is with many long-distance transmission plants. The lower the resistance of the short circuit the more violent will be its effects; there are numberless ways in which they can occur, and they often happen in the most unlooked-for places.

Suppose in Fig. 2 we have water flowing from tank *A* to tank *B* through the long length of small pipe *cc*. This may be taken to represent the flow of current in Fig. 1 under ordinary conditions. The pipe *cc* is long and of small cross-section, hence it offers considerable resistance to the flow of water and no great rush of water can flow from *A* to *B*. Suppose, however, that a large pipe *d* is attached to the bottom of *A* and led directly to *B*. If this pipe is opened a large rush of water will take place between *A* and *B* because the pipe *d* will offer little or no resistance to the flow. The pipe *d* constitutes a short circuit for the flow of water from tank *A* to tank *B*, just as the wire *x* in Fig. 1 constitutes a short circuit or low resistance path from the trolley wire to the rail. The water pressure, which in Fig. 2 is due to the fact that *A* is some distance above *B*, corresponds to the voltage or pressure or electromotive force maintained by dynamo *A*, and the stream of

when the pipe *d* was open, the pump would have to work very much harder to keep up the level in tank *A* than when pipe *cc* only was in use, because it would have to pump a much larger quantity of water in a given time. In other words, the short circuit results in heavy load being thrown on pump *C*, which

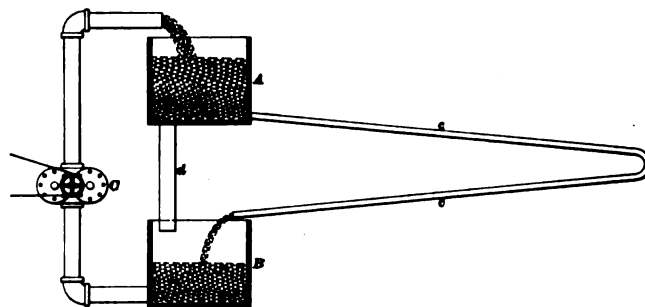


FIG. 2.

corresponds to dynamo *A*, because, after all, a dynamo is really a pump in a sense; it serves to maintain an electrical pressure between the terminals of the dynamo just as the pump *C* maintains a water pressure between *A* and *B*.

Most dynamos in ordinary use are constructed so as to maintain a nearly constant pressure even though they may be called upon to deliver a heavy current. Now, with a given water pressure between tanks *A* and *B*, it is easily seen that the size of the current we get between them is only a matter as to how large we make the pipe *d*. The bottom might be knocked out of *A* so that there would be practically no limit to the flow. This would correspond to connecting a heavy copper bar directly across the terminals $+$ $-$ of the dynamo *A*, Fig. 1, and would constitute what is generally called a "dead short circuit."

In the case of our pump arrangement a heavy flow of water between the tanks would not likely result in any very great damage, but with a dynamo it would be different. We are generally familiar with the fact that, if a current flows through a wire, the wire becomes warm. If the current is large enough the wire may be made red hot, and this heating effect increases very rapidly as the current increases. Also every station man knows that a heavy rush of current is sure to make a dynamo flash and cut up at the brushes, blistering the commutator and making no end of trouble, to say nothing of the strain which is thrown both on the dynamo and engine. A bad short circuit, therefore, if continued for any length of time will be almost sure to overheat or burn out the armature and put the commutator in bad condition.

Remember that all constant potential dynamos such as are used for almost every purpose except arc lighting maintain a nearly constant pressure, and the current that they will deliver depends only upon how good a path is provided for the current to be set up through. If you go poking behind a live switchboard with a monkeywrench and get it across the main switch terminals or bus-bars there is going to be a display of fireworks, and it will all happen so quickly that you will be lucky if you are not burned or your eyes injured.

Arc-light dynamos are constructed so that if the resistance on which they are working is suddenly lowered, the pressure which they generate suddenly lowers also. The consequence is that if these machines are short circuited no great rush of current takes place. The machines are provided with an automatic regulator which looks after the voltage. These dynamos are designed to maintain a constant current, not a constant pressure, and no devices are needed to protect them from short circuits.

From the above, then, it will be seen that it is necessary to have a dynamo and its outgoing circuits protected so that if a short circuit takes place the defective circuit will be at once cut off. In former days this was done altogether by fuses which were simply strips of soft metal, usually consisting of a mixture of lead and bismuth, inserted in the circuit. These fuses would carry the normal current all right, but if any large rush took place they would melt and open the circuit before damage was

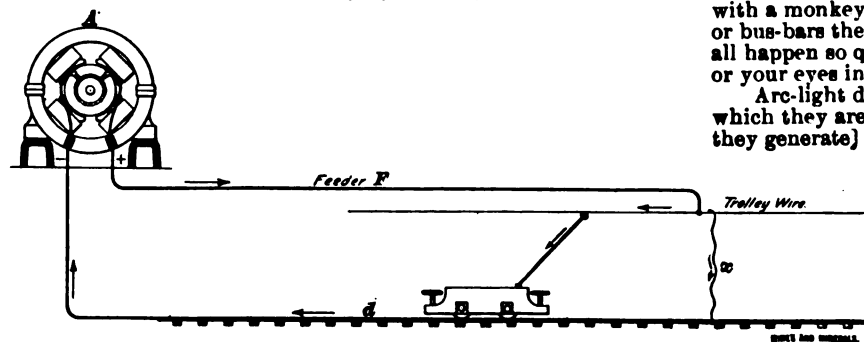


FIG. 1.

water in the pipes *c* and *d* corresponds to the current furnished by the dynamo under the conditions of ordinary working and when working on a short circuit. If the difference in levels of the water in tanks *A* and *B* were maintained by means of a rotary pump *C*, the pressure between the tanks would be constant; but

done—at least this is what they were supposed to do, but they did not always do it because it took the fuses some time to heat up, and in the meantime damage was often done. Fuses are still largely used, especially when the circuits do not have to carry very heavy currents, as in interior wiring installations for lighting buildings. In stations, however, they are giving place to circuit-breakers, and in power houses, where violent overloads occur so frequently, fuses are hardly used at all. The circuit-breaker is essentially an automatic switch which opens whenever the current exceeds the amount for which it is set. The construction of circuit-breakers and the advantages of circuit-breakers over fuses are, however, beyond the scope of this article.

Rock-Forming Minerals.

The chemist tells us that there are about seventy different substances which he calls *elements*, because they cannot be broken up into simpler substances by any means at present at our disposal. These elements may be either gaseous, liquid, or solid in form, and the properties and characteristics of the several elements differ widely.

A complete list of the chemical elements, together with the symbols by which they are commonly known, and their properties, can be found in "The Coal and Metal Miners' Pocketbook," or in any textbook on chemistry. Comparatively few of the elements are, however, of such general importance as to require consideration from any but the chemist. The list of elementary substances, as now printed, may be extended or contracted at any time, owing to the discovery of elements which are now unknown, or from the fact that substances now thought to be elements may be discovered to be combinations of several elements. Such discoveries are being constantly made, and, therefore, we stated above that there are *about* seventy elements and did not give an absolutely fixed number.

The elements which are of such common occurrence in the mineral world as to be of importance to the practical miner or metallurgist, who does not care to enter fully into the study of chemistry and mineralogy, are about forty in number. These common elements are given in the following table, together with their appropriate chemical symbols and atomic weights:

Element.	Symbol.	Atomic Weight.	Element.	Symbol.	Atomic Weight.
Aluminum	Al	27.5	Lead (plumbum)	Pb	207.0
Antimony (stibium)	Sb	120.0	Magnesium	Mg	24.0
Argon (?)	A		Mercury (hydrargyrum)	Hg	200.0
Arsenic	As	75.0	Manganese	Mn	55.0
Barium	Ba	137.0	Molybdenum	Mo	96.0
Bismuth	Bi	208.0	Nickel	Ni	58.8
Boron	B	11.0	Nitrogen	N	14.0
Bromine	Br	80.0	Oxygen	O	16.0
Cadmium	Cd	112.0	Phosphorus	P	31.0
Calcium	Ca	40.0	Platinum	Pt	197.0
Carbon	C	12.0	Potassium (kallium)	K	39.0
Chlorine	Cl	35.5	Silicon	Si	28.0
Chromium	Cr	52.5	Silver (argentum)	Ag	108.0
Cobalt	Co	59.0	Sodium (natrium)	Na	23.0
Columbium	Cb	93.7	Strontium	Sr	87.5
Copper (cuprum)	Cu	63.0	Sulphur	S	32.0
Fluorine	F	19.0	Tellurium	Te	127.0
Gold (aurum)	Au	196.7	Tin (stannum)	Sn	108.0
Hydrogen	H	1.0	Titanium	Ti	48.0
Iodine	I	127.0	Tungsten (wolfram)	W	184.0
Iron (ferrum)	Fe	56.0	Zinc	Zn	65.0

A *chemical compound* is composed of two or more elements chemically combined. Such a compound invariably has the same composition, under whatever conditions it may be found, and it usually differs very materially in appearance, form, and properties from all of the ingredient elements of which it is composed. A characteristic feature of a chemical compound is this uniform and homogeneous structure and composition. For example, take common salt. This article, with which every one is familiar, is composed of the two elements, sodium (Na) and chlorine (Cl); the former a metallic and easily combustible solid element, and the latter a green, poisonous, and gaseous one. When these two elements unite in proper proportions, the result is a compound called sodium chloride or common salt, which is totally different from either of its ingredients in every way, and no one would for a moment think of tracing any connection whatever between the deadly chlorine gas and the wholesome and common article of diet, table salt.

A *mineral* is an inorganic substance having a definite chemical composition and composed either of a single element or of several elements united in the form of a compound. By inorganic, we mean, of course, something that has no life in it and does not grow and multiply as do the ordinary living things, such as animals and plants. We do not mean to say that minerals do

not grow, but their method of growth is entirely different from the growth of a living thing, such as a plant or animal. The manner in which a mineral grows will be spoken of later on, and does not need to be considered here.

A *chemical mixture* is composed of two or more elements or compounds, which, while intimately associated, are not chemically combined. Each constituent of a mixture retains its individual properties, and the several ingredients composing it can often be readily distinguished by the eye, and often even separated by hand. For instance, while white sand and white sugar can be so intimately mixed as to pass for pure sugar, it is a comparatively easy matter to separate the two by a careful examination, even without the use of a microscope.

A *rock* or *stone* consists of a single mineral or of a mixture of two or more minerals. In some rocks, the minerals are mixed in a more or less definite proportion, but a rock differs from a mineral from the fact that it does not necessarily have a definite composition, and its constituent minerals do not necessarily enter into its composition in a definite proportion. Hence, while a mineral is a chemical compound and has a definite composition, a rock is simply a mixture, and the same rock under different conditions and in different localities may vary greatly in composition. To illustrate this point further, the mineral quartz is a definite compound of silicon and oxygen, and is always represented by the chemical symbol SiO_2 , and whenever this mineral is found, it will have this composition. All sandstones are made up of minute grains of quartz, but these grains may be cemented and held together by any one of a number of different cementing materials, so that while the individual grains of sand in different sandstones may be identical in composition, the complete rocks made up of these grains will vary greatly in different localities, and it is therefore impossible to give any definite chemical formula or symbol which will represent all varieties of sandstone.

Again, take the rock granite, which is usually defined as being made up of three minerals—quartz, feldspar, and mica (although many authorities omit the third mineral and define granite simply as a mixture of quartz and feldspar). Quartz is a mineral, and therefore a chemical compound of silicon and oxygen. The compound quartz differs materially from either of its ingredients, silicon or oxygen, and its appearance does not indicate in any way that it is composed of several substances. Feldspar is also a chemical compound, which is made up of four or five different elements, dependent upon the variety of feldspar. This compound also differs materially from either of the ingredients, and shows no sign of its compound character. The same is the case with mica. When, however, we observe the composition of granite, we can easily designate, by eye, each of its constituent minerals. These do not enter into its composition in any definite proportion, and while one granite may be very largely composed of quartz, with very little feldspar and mica, another may be very largely composed of feldspar, with very little of the other ingredients.

Mineralogy, or the study of minerals, treats of the composition and of the chemical and physical properties of minerals. Prof. Dana in his small book on mineralogy enumerates over 2,000 different minerals, but only a comparatively few of these are of practical every-day interest, and the most of them are never seen excepting in mineralogical collections and in museums. In the articles which follow, in this series, we shall therefore confine ourselves to a discussion simply of such minerals and rocks as we may expect to find in connection with the practical work of the miner, and shall not go into the discussion of those branches of the subject for which we must go for examples to the museum or the cabinet collection of the mineral collector.

Lithology, or the study of rocks, treats of the composition and of the chemical and physical properties of the rocks which compose the earth's crust. As is the case with minerals, there are also many hundreds of rocks which are of interest to the scientific lithologist, and which will be found in museum collections, but, fortunately for the busy man, who cannot devote the time to the study of these subjects that he often wishes to do, the number of rocks found in ordinary every-day work and which are of practical importance is very small.

Before undertaking the study of rocks, we must familiarize ourselves with the principal earthy or crystalline minerals composing them. We should also become acquainted with those minerals that are closely associated with the valuable portions of a vein or bedded formation. Since these essential rock-making minerals are so comparatively few, we ought to know them well, and to know them, first as individual specimens, and secondly be able to recognize them as elements of rock masses in the field.

It is quite a different thing to study a collection of minerals in a cabinet to meeting the same minerals in the field or in the depths of a mine. In the former case, you will notice that most specimens in a cabinet are either individual crystals, individual minerals, or groups of crystals and minerals, every one of them more or less a gem, so to speak, washed and cleansed in acids.

But this is far from the general experience in the mining field. For one crystal, perfect or imperfect you may find in the rocks and mines, you will find a hundred that present no definite crystalline form, but are in masses, so crushed together that no distinct crystal form is discernible. When we do find well-defined crystals either in rocks or mines, we look upon them as exceptional cases, as uncommon specimens to be carefully collected. A very large proportion of these beautiful individual crystals are found in those occasional cavities called "geodes" or "vugs" in mines or rocks, but not as distinct constituents of the average vein, or of the country rock. Hence, we may begin by studying the crystal in the cabinet to get a conception of what such a crystal should be in its ideal form, and then go amongst the rocks and down into the depths of the mine, to find the natural appearance and association of these crystals in great masses, and often under very unfavorable circumstances for study.

Most of us have seen the beautifully clear crystals of quartz in the jeweler's store, or in the mineralogist's cabinet, but how does quartz look when it is but one of several constituents of the rocks we call granite or conglomerate, for example. There we only see a small irregular spot of gray, crushed, vitreous material, as little like the original crystal in appearance as mashed potato is like an average potato tuber. There is something a little deceptive in studying book mineralogy, with its ideally perfect geometrically drawn crystals, or even in studying a museum, with its ideal gems, as a preparation for the field, or still more for the mines, where determinative mineralogy consists a good deal in analyzing the difference between various forms of dirt. In the next article we will begin a description of the common rock-forming minerals.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *appears* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 516 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Mineral Paints.

Mr. E. W. Parker in the report of the U. S Geological Survey says: "The mineral substances included under this heading are those which are mined and prepared primarily as pigments. They consist of iron ores (usually hematites) which are ground and used in the manufacture of red and brown pigments, and which are not included in the production of iron ores for iron making; clay and other earths containing iron, used in making yellow and brown pigments, such as ochre, umber, sienna, etc.; barytes (barium sulphate) or "heavy spar," used as a substitute for, or an adulterant of, white lead; slate, or shale; soapstone; asbestos; graphite; and a pure form of gypsum producing terra alba. All of these pigments are made directly from the crude minerals and may be considered natural pigments. It is not always possible, however, to segregate the amount of soap stone, asbestos, and graphite which goes into paint, and reports of the mineral-paint product are therefore partially included in the papers relating to those materials. Venetian red, obtained from iron sulphate by roasting, is also included among the mineral paints, as the amount of iron so consumed is so small when compared with the iron product that it would not affect the total. Zinc white is produced directly from the ores and properly belongs in the product of pigments.

To the above should be added the preparations made from pig lead, namely, white lead, red lead, litharge, and orange mineral; also vermilion, made from quicksilver; chrome yellow, made from potassium bichromate; blanc fixe, made by treating barium carbonate with sulphuric acid and precipitating artificial barytes. The bases from which these pigments are obtained are included in the production of pig lead, quicksilver, chromium, etc., and the pigments themselves, being the results of chemical decomposition and combination, are not grouped among the "mineral paints," although the statistics of white lead, etc., are treated in this chapter. It has also been customary to treat barytes separately.

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Mine Managers' Examination Held at Nanaimo, B. C., Canada, December 12, 13, and 14, 1900.

This examination was divided under the following heads:

(a) Mining Machinery, (b) The Coal Mines Regulation Act and the Special Rules in force in the district, (c) The Practical Working of Collieries, (d) Colliery Surveying and Leveling, (e) Mine Gases, (f) Ventilation of Coal Mines.

MINING MACHINERY.

Ques. 1.—What is meant by a unit of work?

Ans.—A unit of work is the work performed in raising a unit of weight through a unit of vertical height. The units adopted in English and American practice are the pound and the foot, making the unit of work the work performed in raising one pound through a vertical height of one foot. This is a foot-pound.

Ques. 2.—How many units of work does a man weighing 150 pounds perform by ascending a hill 60 feet high?

Ans.—Disregarding friction the work performed is $150 \times 60 = 9,000$ foot-pounds.

Ques. 3.—What weight would a single engine of the following dimensions lift? Diameter of cylinder, 12 inches; length of stroke, 18 inches; average steam pressure, 50 pounds per square inch; geared 4 to 1; diameter of drum, 6 feet.

Ans.—Total cylinder pressure = $.7854 \times 12^2 \times 50 = 5,654.9$ lb. The weight this engine will lift, disregarding friction, is, then, $5,654.9 \times 18 \times 4 = 5,654.9$ lb.

6×12

Ques. 4.—Find the horsepower of an engine with two cylinders 30 inches diameter, 5-foot stroke, 60 strokes per minute, with average pressure of steam 30 pounds per square inch, and average back pressure of 4 pounds per square inch.

Ans.—It is customary to calculate the horsepower of a duplex engine by calculating the power of one cylinder only, since the two cranks are set at right angles to each other upon the crankshaft, the one cylinder thereby exerting its full force when the other cylinder is powerless, its crank being upon dead center. The average effective cylinder pressure in this case is $30 - 4 = 26$ lb. per sq. in. The horsepower of the engine is calculated thus:

$$H = \frac{PLAN}{33,000} = \frac{26 \times 5 \times (.7854 \times 30^2) \times 60}{33,000} = 167.076 \text{ H. P.}$$

Ques. 5.—What weight can be lifted with a screw jack which requires two revolutions to raise one inch; the length of lever 20 inches; friction to be omitted?

Ans.—Disregarding friction and assuming a force of 100 pounds applied at the end of a lever 20 inches in length, the weight lifted is $W = 2(2 \times 3.1416 \times 20 \times 100) = 25,132.8$ lb.

Ques. 6.—A pipe line in a slope has an area of 144 square inches and is 2,000 feet long; the slope is on a grade of 1 in 10. What is the pressure per square inch at the bottom of the pipe when it is full of water?

Ans.—The vertical fall of the slope is $\frac{2,000}{10} = 200$ ft. The static pressure of the water at the bottom of the pipe is, then, $200 \times .434 = 86.8$ lb. per sq. in. The sectional area of the pipe (144 sq. in.) does not enter the solution of the problem in this case.

Ques. 7.—What are the usual appendages to colliery boilers, and their utility? What are the requirements of the Coal Mines Regulation Act with reference to them?

Ans.—The usual boiler fittings, appendages, and their uses, may be described as follows: Safety valves for relieving any excess of pressure in the boiler above the pressure permitted or required for the working of the boiler; a gauge glass for showing the height of water in the boiler; try-cocks, of which there are usually three, for testing the height of the water in the boiler; the mud drum for the collection of sediment deposited from the water in the boiler; the blow-off valve for draining and scouring the boiler; the steam separator for drying the steam before it enters the cylinder of the engine; the feed-pump or injector for filling

the boiler; and the feedwater heater for raising the temperature and for the purification of the feedwater entering the boiler. General rule 26 requires that every steam boiler shall be provided with a proper steam gauge, water gauge, and safety valve.

Ques. 8.—What thickness of steel plates is required in the shell of a cylindrical boiler 60 inches in diameter, for a safe working pressure of 100 pounds per square inch, the tensile strain on plate not to exceed 8,000 pounds per square inch—no allowance to be made for joint?

Ans.—The required thickness of the steel plates in this case is $\frac{100 \times 60}{2 \times 8,000} = \frac{3}{8}$ in.

Ques. 9.—At a certain mine it is proposed to erect a 14-foot fan in place of the furnace in use at present—the quantity of air is 120,000 cubic feet, with water gauge 1.5 inches. Give the revolutions per minute required for this fan to circulate the same quantity of air with the same water gauge.

Ans.—The method in common use for determining the speed of rotation or the number of revolutions of the fan per minute is by using the formula

$$i = \left(\frac{\pi d n}{60}\right)^2 \times \frac{1}{g} \times \frac{1.2 \times 12}{1,000},$$

or, $n = 902.5 \sqrt{\frac{i}{d}}$.

In this formula n = speed of rotation of the fan (rev. per min.);
 d = diameter of the fan (ft.);
 g = force of gravity (32.16);
 i = theoretical water gauge (in.).

Assuming a manometrical efficiency of 50 per cent. the theoretical water gauge in this case is $i = \frac{1.5}{.50} = 3.0$ in., and substituting the given values in the above equation, we have for the required speed,

$$n = 902.5 \sqrt{\frac{3.0}{14}} = 111.66 \text{ rev. per min.}$$

[It must not be supposed from the above solution that a 14-foot fan running at a speed of 111.66 revolutions per minute will produce a water gauge of 1.5 inches irrespective of the conditions of resistance in the airway into which the fan is discharging its air. For example, if this fan is made to do service at another mine where the conditions of resistance are different, it will give a different water gauge and quantity at the same speed. This amounts to the same thing as saying the fan will present a different efficiency for each circulation. (See article, Manometrical Efficiency, What It Means, page 524.)]

Ques. 10.—The diameter of the water piston of a direct-acting steam pump requires to be 15 inches to pump the water from a certain mine; the height of the lift is 310 feet. What should be the diameter of the steam cylinder? What quantity will be delivered in gallons at a piston speed of 100 feet per minute, pressure of steam 50 pounds per square inch?

Ans.—The rule to apply in this case is to make the ratio of the areas or the square of the ratio of the respective diameters of the water and steam cylinders equal to the inverse ratio of the effective pressures at the water and steam ends.

Thus, $\frac{a}{A} = \left(\frac{d}{D}\right)^2 = \frac{.75 p_s}{.85 p_w}$;

In which d = diameter of the water piston or plunger (in.);
 D = diameter of the steam cylinder (in.);
 a = area of the water piston or plunger (sq. in.);
 A = area of steam cylinder (sq. in.);
 p_s = steam cylinder pressure (lb. per sq. in.);
 p_w = water pressure (lb. per sq. in.).

We assume, as is customary, an efficiency of 75 per cent. at the steam end, and 85 per cent. at the water end.

Then, $d = D \sqrt{\frac{.75 p_s}{.85 p_w}} = 15 \sqrt{\frac{.75 \times 50}{.85 \times .434 \times 310}} = 8.59$ in.

To find the discharge of a pump we have the formula,
 $G = \frac{.85(.7854 d^2 S \times 12)}{231} = \frac{.85(.7854 \times 8.59^2 \times 100 \times 12)}{231}$
 $= 255.9$, say 256 gal. per min.

In this formula G = water discharged (gal. per min.);
 d = diameter of water piston or plunger (in.);
 S = piston speed of the pump (ft. per min.).

Ques. 11.—The diameter of a safety valve on a colliery boiler is 4 inches; the pressure of steam 65 pounds per square inch; distance of valve from fulcrum 4 inches; length of lever from fulcrum 36 inches; weight of lever 10 pounds; weight of valve 4 pounds. What weight will be required at end of lever so that the steam will blow off at this pressure?

Ans.—In this question the sum of the moments of the weight at the end of the lever, the weight of the lever, and the weight of the valve respectively, must equal the moment of the total steam pressure on the valve. Hence, we have, calling the required

weight x , and assuming the lever as having a uniform cross-section its entire length,

$$36 \times x + 10 \left(\frac{36}{2}\right) + 4 \times 4 = 65(.7854 \times 4^2) \times 4, \text{ or } x = 85.3 \text{ lb.}$$

Ques. 12.—A hauling engine draws coal up an incline 1,100 yards long, rising 1 in 5. In 6 hours continuous working 500 tons of coal are raised, the conditions being as follows: System of hauling, endless rope; tube attached to rope in couples 20 yards apart, going in and coming out; full tub weighs 10 cwt., empty tub weighs 3½ cwt.; weight of rope 5½ tons, of coupling chains 15 cwt.; friction $\frac{1}{5}$ of load. What is the effective horsepower of engine?

Ans.—Let O = output (lb. per min.);
 v = speed of winding (ft. per min.);
 l = length of haulage road (ft.);
 c = capacity of mine car (lb.);
 w_1 = weight of mine car (lb.);
 w = weight of rope (lb.).

Then, $\frac{lO}{v}$ = weight of coal in transit; $\frac{2lO}{vc} \times w_1$ = weight of moving cars, loaded and empty; $\frac{lO}{v} \left(1 + \frac{2w_1}{c}\right) + w$ = entire moving load. Then, since the coefficient of friction in this case is $\frac{1}{5}$, the friction pull of this load is $\frac{1}{5}$ of the entire moving load. Substituting the given values, we first calculate the speed of winding by dividing the output per minute by the weight of coal per lineal foot of rope. For the output per minute we have,

$$O = \frac{500 \times 2,000}{6 \times 60} = 2,778 + \text{lb. per min.}$$

The weight of coal per lineal foot of rope is found by dividing the capacity of two cars by 60, since there are two cars upon the rope in every 20 yards. Hence, we have for the speed of hauling,

$$v = \frac{500 \times 2,000}{6 \times 60} \times \frac{60}{2 \times 650} = 128.2 \text{ ft.}$$

For the friction pull of the entire moving load we have,

$$p_f = \frac{1}{50} \left[\frac{3 \times 1,100 \times 2,778}{128.2} \left(1 + \frac{2 \times 350}{650}\right) + (5.5 \times 2,000 + 1,500) \right] = 3,220 \text{ lb.}$$

The horsepower absorbed by the friction is, therefore,

$$H = \frac{3,220 \times 128.2}{33,000} = 12.5 \text{ H. P.}$$

Since the weight of the ascending cars and rope upon the incline balances that of those descending, the only work performed owing to the incline is that due to elevating the coal through the vertical height of the incline, or $\frac{3 \times 1,100}{5} = 660$ feet; and for the horsepower for this purpose, we have,

$$H = \frac{2,778 \times 660}{33,000} = 55.5 \text{ H. P.}$$

And for the total horsepower for this haulage we have $H = 12.5 + 55.5 = 68 \text{ H. P.}$

Ques. 13.—It is desired to wind 1,500 tons of coal per day from a shaft 18 feet in diameter, 700 feet deep, in 8 hours. Explain what appliances you would adopt to insure this, and give dimensions of winding engines, cages, tubs, and ropes.

Ans.—The output equals 1,500 tons in 8 hours, or,
 $\frac{1,500 \times 2,000}{8 \times 60} = 6,250 \text{ lb. per min.}$

We may assume in this case a speed of hoisting of, say 35 feet per second, and allowing 20 seconds for change of cars between each hoist, the time consumed in one hoist is $\frac{700}{35} + 20 = 40 \text{ sec.}$ Then,

for the output per hoist we have, $\frac{6,250 \times 40}{60} = \text{say } 4,000 \text{ lb.}$ Two

cars should be hoisted at a time, either side by side or on a double-deck cage. This will depend upon the form and size of mine cars employed as determined by the character of the seam and the nature of the roof and floor. A soft bottom or a weak top necessitates narrow cars which can be hoisted side by side on a wide cage; while a thin seam would require wide cars and a double-deck cage. In using such a cage, arrangements should be made at each landing to unload both cars at one time. Assuming these latter conditions, the car to have a capacity of 2,000 pounds of soft coal should have a cubical contents of from 35 to 40 cubic feet, according to the character of the coal. The inside measurement of the car will then be, say 5 ft. $\times$ 2½ ft. $\times$ 3 ft. Such a car will require a cage having a platform, say 7 ft. long and 5 ft. wide in the clear, and which would weigh, say 4,000 pounds. The weight of the loaded cars is, say 3,000 pounds, the weight of the empty cars being 1,000 pounds. The weight of the cage and loaded cars is then, $4,000 + 2(3,000) = 10,000$ pounds. A 1-inch plough-steel,

6-strand, 19-wire rope weighing 1.58 pounds per foot, and having a breaking strain of 44 tons should be employed. The weight of this rope would be $700 \times 1.58 =$ say 1,100 pounds. The entire weight hoisted is then, $10,000 + 1,100 = 11,100$ pounds, giving a factor of safety of $\frac{44 \times 2,000}{11,100} = 8$, nearly.

To calculate the size of engine required for this hoist, we first find the unbalanced load upon the engine. Assume a double hoist having the rope unbalanced. The net load upon the engine is then, $4,000 + 1,100 = 5,100$ pounds. The gross load is $2(4,000 + 2 \times 1,000) + 5,100 = 17,100$ pounds, and taking, as is customary, $\frac{1}{3}$ of this gross load for the friction of the hoist, or say 1,700 pounds, we obtain for the total working load, $5,100 + 1,700 = 6,800$ pounds. For this depth of shaft (700 ft.) we would use a second-motion engine geared 1:3, and a winding drum 10 feet in diameter. The speed of the winding being 35 feet per second, the engine will make $3 \left(\frac{35 \times 60}{10 \times 3.1416} \right) = 200.5$ rev. per min. Then, for the diameter of the cylinder of the engine we have (see page 379, MINES AND MINERALS, March, 1900), assuming a mean effective cylinder pressure of 65 pounds per square inch and a ratio of length of stroke to diameter of the piston, $r = 1.5$,

$$d = \sqrt{\frac{2LD}{pr r_1}} = \sqrt{\frac{2 \times 6,800 \times 10 \times 12}{65 \times 1.5 \times 3}} = 17.74 \text{ in.}$$

We would, therefore, use a duplex second-motion 18 in. $\times$ 27 in. engine making 400 strokes per minute. This engine is geared to a winding drum 10 feet in diameter, the ratio of gearing being 1:3.

Ques. 14.—Is there any loss by converting steam power into compressed air? If so, what are the causes?

Ans.—Loss arises from three causes. (1) Mechanical losses from the running of the compressor. (2) Loss due to compression of the air, varying in amount with the gauge pressure, and whether or not the air is reheated. (3) Loss due to transmission, frictional loss and leakage.

GENERAL WORK.

Ques. 1.—In which case, in your opinion, does the greater necessity exist for timbering, when the shaft is sunk through measures pitching 70° or through the same measures pitching 5°?

Ans.—There is the greater necessity for timbering where the inclination of the measures is steeper, or in the 70° pitch. The reason for this is that the line of fracture, which usually takes a direction across the strata, draws across the shaft more as the pitch of the strata increases.

Ques. 2.—What dangers may arise from lack of judgment in the placing of shots in the coal?

Ans.—(1) The charge may be located too far on the solid and the powder thereby given no opportunity to perform its work, as for example, when the shot is not sufficiently cut or mined. (2) The amount or grade (size) of powder employed may not be adapted to the work. The smaller grained powder should be used where the coal is hard and tough, but a slower or a larger grained powder should be employed in softer coal and in pillar work. (3) The charge may be so located that the line of least resistance is such that the work required of the shot will not be performed. (4) Where the coal has a tendency to seam out, in order to avoid danger the hole should be inclined at an angle with the strata, and the charge should be located in the harder strata of the seam. (5) The hole may be of too large a diameter, or the stemming may be too light and not of proper material. (6) Where more than one shot is fired at the same time danger may arise from placing these shots so that the work of one of them depends upon the previous work of another, in case the shots do not explode in the expected order.

Ques. 3.—If the pillars in a vein of coal 8 feet thick are left 7 yards wide at a depth of 230 feet, how wide should pillars be left at a depth of 895 feet in a vein 20 feet in thickness, of the same quality of coal?

Ans.—A safe rule is to make the width of pillars in mine workings proportional to the square root of the product of the depth of the seam times its thickness, giving in this case,

$$x = 7 \sqrt{\frac{895 \times 20}{230 \times 8}} = 21.83 \text{ yd.}$$

Ques. 4.—What is the comparative strength of stringers—one 12 inches in diameter and 8 feet long, the other 16 inches in diameter and 12 feet long?

Ans.—For beams of a circular cross-section the strength of the beam is proportional to the cube of its diameter, and inversely proportional to the length of the clear span. Calling the strength of the first timber mentioned 1, that of the second timber is $\left(\frac{16}{12}\right)^3 \times \frac{8}{12} = 1.58$. Hence, the timber 16 inches in diameter and 12 feet long is 1.58 times as strong as the timber 12 inches in diameter and 8 feet long.

Ques. 5.—Explain the principle and construction of the safety lamp?

Ans.—This question is fully answered in reply to Ques. 5, page 379, MINES AND MINERALS, March, 1901.

Ques. 6.—In approaching an abandoned mine full of water having a head of 300 feet, the pillars of which have been extensively robbed, how much of a barrier pillar would you consider it necessary to leave for the safety of your workings, so that you could rob your pillars back in a seam of free coal 8 feet thick on a pitch of 12°?

Ans.—The bituminous mine law of Pennsylvania specifies for a minimum thickness of barrier pillar, $1\frac{1}{2}$ feet of thickness for each foot of head of water. Applying this rule we have in this case for the thickness of pillar, $300 \times 1\frac{1}{2} = 375$ ft. We would apply this rule to seams not exceeding 8 feet in thickness; for thicker seams we would increase the thickness of the pillar in the ratio of the thickness of the seam. Thus, for this seam 8 feet thick, we would increase the thickness of the pillar in the ratio $\frac{8}{4}$; thus, $375 \times \frac{8}{4} = 500$ ft.

Ques. 7.—Explain the meaning of the term specific gravity, and state how you would determine the specific gravity of coal?

Ans.—The specific gravity of a body is the relative weight of that body as compared with the weight of an equal volume of a given standard. The usual standard for solids and liquids is

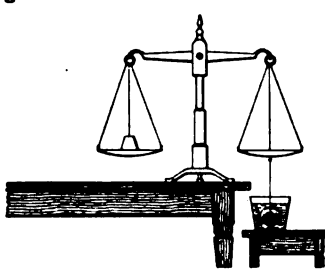


FIG. 1.
MINES AND MINERALS.

water, while that for gases is air. Specific gravity means relative weight. To find the specific gravity of a piece of coal, first find the exact weight (W) of the coal on a sensitive balance, then ascertain its weight (w) when suspended in water by a horsehair, from one end of the balance beam, as shown in Fig. 1. The difference ($W - w$) between these two weights is the buoyancy of the water and is the weight of the water displaced or the weight of an equal

volume of water. The ratio of the weight of the coal to the weight of an equal volume of water is the specific gravity of the

coal. Thus $\text{Sp. Gr.} = \frac{W}{(W - w)}$.

Ques. 8.—Describe, with sketches, the various appliances which are in use for boring. Suppose you had to put down a hole from the surface to a depth of 300 yards, how would you proceed, and what should you estimate as the cost, there being no extraordinary difficulties to contend with?

Ans.—For description of various prospect drilling machines see article Diamond Drilling Machines, page 241, MINES AND MINERALS, January, 1900. In sinking a prospect bore hole 300 yards in depth, the diamond core drill should be employed. The cutting tool or bit of the machine consists of a short section of pipe in the end of which are set large rough diamonds which protrude beyond the outer and inner edges of the bit so as to cut a clearance for the drill rods in the hole. The rods are lengthened by adding sections of pipe as the hole increases in depth. The cost of drilling varies very greatly; holes have been put down to a depth of 500 feet in sandstone and shale at a cost of 44 cents per foot. As a general rule the cost of drilling may vary anywhere from \$1 to \$5 per foot, increasing with the depth of the hole and the character of the strata. (See Coal and Metal Miners' Pocketbook, 6th edition, page 242.)

Ques. 9.—The accompanying sketch (Fig. 2) represents the relative positions of three bore holes, marked 1, 2, and 3. The proposed position of a shaft is marked on the sketch at 4. The distance from 1 to 2 is 500 yards, from 2 to 3, 180 yards, and from 3 to 4, 320 yards. The line 3 to 4 is at right angles to the line 1 to 2. A seam of coal is found at a depth of 180 ft. at 1, 260 ft. at 2, and 275 ft. at 3. Assuming a level surface. (a) What will be the depth of the shaft at 4? (b) How far back on the line 1-2 will you have to go to find the coal at the same depth as at 4? (c) How far will the line 1-2 require to be prolonged to find the coal at the same depth as at 3? (d) Find the direction and the amount of dip of the seam. (e) Make a sketch and show the direction of the dip and also of the strike of the seam.

Ans.—(a) The surface being level the depths of the several

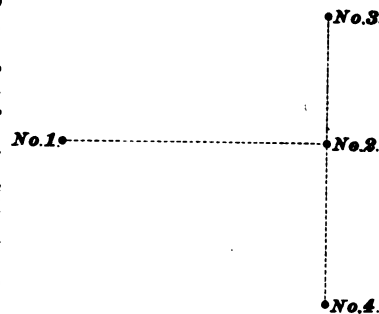


FIG. 2.

QUES. 3.—Where are they found, and how produced? Give their effect on life; effect on combustion; and their general characteristics.

ANS.—The lighter mine gases, as carbureted hydrogen (CH_4), and carbonic oxide gas (CO) accumulate near the roof and the upper portions of mine workings, while the heavier gases, as sulphureted hydrogen (H_2S) and carbonic acid gas (CO_2) accumulate near the floor and in the lower workings of the mine. Marsh gas is produced by the metamorphism of carbonaceous matter away from air and in the presence of water, and is one of the products of the formation of every coal seam. The fact that a coal seam is gaseous or otherwise is due to the fact that this gas has been retained or has escaped, as the case may be, according to the character of the overlying strata. If the cover of the seam is impervious to gas the gas is retained in the coal, while pervious strata, and fissures and faults allow the gas to escape to the surface, and the seam becomes a non-gaseous seam. Carbonic acid gas (CO_2) is produced by the complete combustion of carbonaceous matter in a plentiful supply of air. The combustion may be a slow combustion as occurs in the decomposition of coal in the gob, and the decay of mine timber, etc., or the more rapid combustion of mine fires, burning of lamps, etc. This gas is also produced by the breathing of men and animals. Carbonic oxide gas (CO) is the result of the incomplete combustion of carbonaceous matter in a limited supply of air. This gas is produced by slow combustion in the gob where the supply of air is limited, and is also the result of mine explosions, blasting, etc., the supply of air being limited in these cases. Sulphureted hydrogen (H_2S) is apparently the result of the decomposition of iron pyrites. This often takes place in the floor of the seam in moist places in the mine. The effect of these gases upon life and combustion, and their general characteristics, have been fully described in the answers referred to in the last question.

QUES. 4.—In dealing with carbureted hydrogen, is any other danger to be guarded against beside that of explosion?

ANS.—Carbureted hydrogen unless sufficiently diluted with air will cause death by suffocation. In avoiding the danger arising from its explosive character as firedamp, we provide at the same time for what other dangers may exist incident to the presence of this gas.

QUES. 5.—Of what is atmospheric air composed?

ANS.—Atmospheric air is composed of nitrogen and oxygen gases in the proportion of 79.3 volumes of nitrogen to 20.7 volumes of oxygen, or, practically, 4 volumes of nitrogen to one of oxygen. There are always traces of carbonic acid gas, ammonia gas, and moisture in the atmosphere.

QUES. 6.—Is firedamp compressible? What effect has a decreased pressure of atmosphere upon it?

ANS.—Firedamp, like all other gases, is compressible. A decrease of atmospheric pressure results in an expansion of the volume of firedamp contained in mine workings, and a large proportion of gas is thus thrown into the air current. There is also some evidence to show a freer transpiration of the occluded gases of coal seams during a fall of atmospheric pressure.

QUES. 7.—Is it possible to have an explosion in a mine where the safety lamp gives no indication of firedamp?

ANS.—A mine explosion may result from a large quantity of fine coal and dust being thrown into suspension in the mine air by the force of a blast. This fine dust acted upon by the flame of the shot distills carbonic oxide gas (CO) and produces what is termed a windy shot. This may result in a serious mine explosion, whether marsh gas is present in the air or not.

QUES. 8.—If the temperature of a mine which has a large volume of air circulating through it is 50° , and the temperature of the outside atmosphere 80° , what effect will this difference of temperature have on the airways of the mine?

ANS.—The effect of the outside air having a temperature of 80° and being cooled in the airways of the mine to a temperature of 50° , would be to deposit a large quantity of moisture in the airways, which is manifested by what is termed the "sweating" of the roof and timbers of the airway. Since the outside temperature is not always as high as 80° , but during the night may be cooled to even less than the temperature of the mine, the result is an alternating dry and moist condition of the airways. This results in the rapid decay of the timber in the airways, often producing a considerable fungus growth upon the timber.

QUES. 9.—Describe the change which takes place in the air of a mine at the moment of an explosion of firedamp.

ANS.—The oxygen of the air is consumed during the explosion, and large quantities of carbonic oxide gas (CO), and carbonic acid gas (CO_2), and moisture or steam are produced. The nitrogen of the air remains unchanged. All of these gases form a mixture which is termed the afterdamp of the explosion. More lives are destroyed by suffocation in the afterdamp than by the force of the explosion itself.

QUES. 10.—How much oxygen will be required for the complete combustion of 100 cubic feet of marsh gas?

ANS.—The chemical equation expressing the reaction that takes place in the complete combustion of marsh gas is as follows: $CH_4 + 4O = CO_2 + 2H_2O$. There are thus, 4 atoms of O (atomic volume 4) consumed in the combustion of one molecule of CH_4 (atomic volume 2), and hence, the volume of oxygen consumed equals twice the volume of marsh gas burned. Therefore, the combustion of 100 cubic feet of marsh gas will require $100 \times 2 = 200$ cu. ft. of oxygen.

QUES. 11.—When gas is exploded what effects are caused by coal dust suspended in the air?

ANS.—The effect is to intensify the force of the explosion and propagate its flame, thereby extending an otherwise local explosion. See also answer to Ques. 7 above.

QUES. 12.—What are the properties of sulphureted hydrogen gas, and how is the presence of this gas detected?

ANS.—This question has been fully answered in reply to Ques. 5, page 230, MINES AND MINERALS, December, 1900.

VENTILATION.

QUES. 1.—If it were known that 1,000 cubic feet of carbureted hydrogen gas per minute was being given off in a district, what amount of air would you require to circulate in the mine in order to dilute and render this gas harmless, and also to provide sufficient air for 100 men and 10 horses?

ANS.—Since the lower explosive limit of marsh gas or carbureted hydrogen (CH_4) is reached when the proportion of air and gas is 1 : 13, any larger proportion of air than this would render the mixture incombustible, as for example, a quantity of air equal to $1,000 \times 13.5 = 13,500$ cu. ft. per minute would render the above quantity of gas incombustible. However, for safe conditions in the mine workings the quantity of gas should not exceed from 2 to 3 per cent. of the mixture; that is to say, 1,000 cubic feet of gas should be 2 per cent. of the entire circulation, the remaining 98 per cent. being pure air. The quantity of air to be supplied to the mine to produce these conditions would therefore be, $\frac{98}{2} \times 1,000 = 49,000$ cu. ft. per minute. This quantity of air is largely in excess of that required by law for the above men and horses.

QUES. 2.—At a colliery ventilated by a fan, the total quantity of air circulated is 130,000 cubic feet per minute, with a water gauge of $2\frac{1}{2}$ inches when the fan is running at a speed of 80 revolutions per minute. What will be the quantity of air produced if the speed of the fan be increased to 100 revolutions per minute? What water gauge and horsepower will be required?

ANS.—The usual method of calculation is

$$\text{Quantity} = \frac{100}{80} \times 130,000 = 162,500 \text{ cu. ft. per min;}$$

$$\text{Water gauge} = 2.5 \left(\frac{100}{80} \right)^2 = 3.9 \text{ in.; and}$$

$$\text{Horsepower} = \frac{130,000 \times 2.5 \times 5.2}{33,000} \left(\frac{100}{80} \right)^3 = 100 \text{ H. P.}$$

In practice, however, the ratio in which the quantity of air is increased is always less than the ratio of the increase of speed, the quantity of air varying as the fifth root of the fourth power of the speed, which gives in this case 155,400 cubic feet per minute, under a water gauge of 3.57 inches, and requires 87.49 horsepower.

QUES. 3.—If 10,000 cubic feet of air per minute will pass in an airway 6 ft. $\times$ 6 ft., 1,000 yards long, what amount will pass in two airways, each 3 ft. $\times$ 6 ft., of the same length and with the same ventilating pressure?

ANS.—For the same pressure the quantity of air in circulation is proportional to the relative pressure potential $a\sqrt{\frac{a}{l \cdot o}}$ (see Coal and Metal Miners' Pocketbook, 6th edition, page 372); or in this case, since the length of the airways are the same, the relative potential is $a\sqrt{\frac{a}{o}}$, and we have,

$$36\sqrt{\frac{36}{24}} : 2 \left(18\sqrt{\frac{18}{18}} \right) :: 10,000 : x;$$

$$\text{or, } x = 10,000 \times \frac{36}{36} \sqrt{\frac{24}{36}} = 8,165 \text{ cu. ft. per min.}$$

QUES. 4.—If, with an upcast temperature of 180° , and a downcast temperature of 48° , the pressure is 5.75 pounds per square foot, what will the pressure be if the upcast temperature is raised to 200° ?

ANS.—The motive column, downcast air (see Coal and Metal Miners' Pocketbook, 6th edition, page 372), is given by the formula $M = D \left(\frac{T - t}{459 + T} \right)$. Then, since the temperature, and, therefore, the weight of the downcast air is constant, the pressure

for the same depth of shaft is proportional to the expression, $\frac{T-t}{459+T}$, and we have,

$$\frac{180-48}{459+180} : \frac{200-48}{459+200} :: 5.75 : x,$$

and $x = 5.75 \times \frac{152}{132} \times \frac{639}{659} = 6.42$ lb. per sq. ft.

Ques. 5.—What horsepower is required to pass 70,000 cubic feet of air per minute when the water-gauge reading is .9 inch?

$$\text{Ans.—} H = \frac{70,000 \times .9 \times 5.2}{33,000} = 9.927 \text{ H. P.}$$

Ques. 6.—The upcast shaft is 300 feet deep, and the temperature 120° F., the temperature of the downcast column being 45° F., what is the height of the motive column?

Ans.—The motive column, downcast air, is,

$$M = 300 \left(\frac{120-45}{459+120} \right) = 38.86 \text{ ft.}$$

The motive column, upcast air, is,

$$M = 300 \left(\frac{120-45}{459+45} \right) = 44.64 \text{ ft.}$$

(See Coal and Metal Miners' Pocketbook, 6th edition, page 372.)

Ques. 7.—When do you consider the quantity of air entering the downcast shaft sufficient for the ventilation of the workings?

Ans.—(a) The quantity of air in circulation must be sufficient to meet the requirements of the mine law. (b) The quantity must be such as to dilute and render harmless the gases issuing from the mine, and to produce a velocity in the airways and at the working face that will sweep away all accumulated gases. When these requirements are satisfied the quantity of air entering the downcast is sufficient for the ventilation of the mine.

Ques. 8.—What method of ventilation lessens the danger of an explosion, and reduces friction? State your reasons for the same.

Ans.—The division of the mine, with respect to ventilation, into separate districts, each district having its own ventilating current. The gases generated in one portion of the mine are not then carried by the air current into another portion, but are delivered directly to the main return airway. If an explosion occurs in one district the men in the other districts can escape without the danger of suffocation from the afterdamp. For the same circulation the velocity in the airways is less and the circulation is thereby reduced.

Ques. 9.—What dangers to life and property are to be guarded against where ventilation is produced by a furnace?

Ans.—In furnace ventilation there is always the danger present of the ignition of the coal or the timbers of the shaft by sparks or the heat of the furnace, and in gaseous mines the danger of the ignition of the gas is imminent. These dangers must be carefully guarded against.

Ques. 10.—How many modes of ventilation are there? Give a description of each.

Ans.—With respect to ventilating systems there are two general methods employed: The method by exhaustion (vacuum system); the method by blowing (plenum system). The first includes all systems in which the pressure in the airway is less than that of the atmosphere, as for example, where ventilation is produced by a natural air column or by a furnace, or by exhaust steam or by means of an exhaust fan. The second system includes all systems in which the pressure in the airway is greater than that of the atmosphere, as when ventilation is produced by means of a wind cowl, waterfall, or a blow-down fan. With respect to the means for producing ventilation, the methods employed may be classified under natural or artificial ventilation. The former refers to all methods employing natural means of ventilation, which includes all natural air columns, wind cowls, waterfalls, etc. Artificial ventilation embraces all methods employing artificial means, and embraces steam jets, furnaces, and all kinds of mechanical ventilators.

Ques. 11.—How would you examine the various safety lamps in common use, as to their safe condition for testing gas, also for working. What appearance has the flame of the lamp when brought in contact with various mixtures of an explosive character?

Ans.—Assuming the question refers to the examination of the different types of safety lamps for purposes of comparing their utility and safety in testing for gas and in general work in the mines, the lamps should be subjected to a gaseous current at different velocities, and in such a way that their behavior may be observed with safety. Experiments of this nature have often been performed by placing the lamps in a box through which currents having known percentages of gas are passed. The appearance of the flame in contact with various mixtures of explosive gas, varies according to the kind of flame employed. The two flames usually employed for testing for gas are the *normal*

flame and a *small uniform flame*. The heights of the flame cap are best observed when using the small uniform flame. In the use of the normal flame the height of the flame increases as the percentage of gas is increased, and when the mixture nears the explosive limit the flame becomes a tall, waving, spindle-shaped flame that rotates about the central axis of the lamp. The brightness of the normal flame prevents observing as closely the flame cap as is possible when a smaller flame is used; but the height of the flame and its general character must be depended upon to determine the percentage of gas present. (See answer to Ques. 3, page 427, MINES AND MINERALS, April, 1901.)

Ques. 12.—If one ventilating fan produces 25,000 cubic feet of air per minute, what total quantity of air per minute will be given if another fan be added to it of the same dimensions and run at the same power?

Ans.—In this case the total power applied is doubled. Assuming that the efficiencies of the ventilators remain constant, the quantity of air circulated in the mine will vary as the cube root of the total powers employed, or in this case $x = 25,000 \sqrt[3]{2} = 31,498$ cu. ft. per min. As a matter of fact, however, the efficiency of the ventilators is increased, since only half of this air, or 15,749 cubic feet is passing through each ventilator under an increased ventilating pressure, resulting in a considerable decrease in the loss of power in the ventilator. We may, therefore, expect a somewhat larger quantity of air than the amount calculated above, as produced by the two fans working together, which may approach 32,000 cubic feet per minute, or even more.

Ques. 13.—What is meant in the science of mine ventilation by the term "equivalent orifice"?

Ans.—This question is fully answered in reply to Ques. 4, page 86, MINES AND MINERALS, September, 1900.

Ques. 14.—An airway is 14 ft. $\times$ 10 ft. and 6,000 ft. long, the quantity of air passing per minute is 45,000 cubic feet, find the pressure; water gauge, and horsepower, using Atkinson's formula.

$$\text{Ans.—} p = \frac{ksq^2}{a^5} = \frac{.000000217 \times 2(14+10) \times 6,000 \times 45,000^2}{(14 \times 10)^5} = 4.612 \text{ lb. per sq. ft.}$$

$$w. g. = \frac{4.612}{5.2} = .887 \text{ in.}$$

$$H = \frac{45,000 \times 4.612}{33,000} = 6.289 \text{ H. P.}$$

Ques. 15.—At a certain mine the water gauge was originally .7 inch; the airways are now 3 times as long, and the velocity has increased from 480 to 600 feet per minute. What will be the water-gauge reading under these conditions?

Ans.—The water gauge being proportional to the length of the airway and the square of the velocity, we have,

$$x = .7 \times 3 \left(\frac{600}{480} \right)^2 = 3.28 \text{ in.}$$

Uses of Vanadium.

Vanadium is used in the manufacture of aniline black, which is formed when vanadic acid or a vanadate is heated with aniline chloride, with reduction to V_2O_4 . The latter oxide may again be made active by oxidation with potassium chlorate, so that the reaction may be often repeated without any fresh addition of vanadium. The method is useful for staining wood black, as well as in producing an indelible black writing ink. When applied to pottery and fired at a high red heat, the oxides give a fine gold color with a greenish tinge.

Alloys of vanadium and other metals have been obtained in considerable variety by first using aluminum. A cast bar of 1 per cent. vanadium had a tensile strength of 11 tons, an elongation of 7 per cent.; aluminum bronze, with 8 parts aluminum and 1 part vanadium, gave 45 tons tensile strength and 12½ per cent. elongation.

Ordinary malleable iron of about 24½ tons tenacity and 19 per cent. elongation, was changed by the addition of 0.5 per cent. vanadium to 39 tons and 12 per cent. elongation in the forged bar, and 33 7/8 tons and 32 per cent. elongation annealed. This has called attention to the remarkable malleability and ductility of the alloy. A mild steel of 30 tons tenacity and 17 per cent. elongation, with 1 per cent. vanadium, gave 61 tons tenacity and 14 per cent. elongation, and when annealed 45 tons and 20 per cent.; and, although very soft when annealed, these alloys become very hard by tempering.

At present there are no steel manufacturers using the oxide in quantity, as the demand for vanadic acid as a mordant in dyeing takes the entire supply from the slags of the Creusot Steel Works in France—about 165,000 lbs. per annum. A large supply should admit of the use of vanadium in the manufacture of steel for armor plate, forgings for ordnance and naval machinery, projectiles, tools, rolls, calendars, etc., and various bronzes.—Kuhlows.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to MINES AND MINERALS.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to MINES AND MINERALS.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to MINES AND MINERALS.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes, and to mention the numbers of the questions when so doing.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for June.

QUES. 684.—*Ore In Sight*.—Explain what is meant by the phrase "ore in sight."

QUES. 685.—*Inclination of Screens for Anthracite Coals*.—What in your experience is the proper pitch or angle of inclination of screens for producing the various sizes of anthracite coal, and how is this inclination affected by the wetness or dryness of the coal?

QUES. 686.—*Size of Screens, Anthracite Coal*.—Describe the different kinds of screens in use, as bar, mesh, revolving, and shaking screens, giving the sizes of bars, wires, and openings in each screen for the preparation of the various grades of anthracite coal.

QUES. 687.—*Consumption of Steam Per Horsepower Per Hour*.—What factors determine the theoretical consumption of steam in an engine of a given type? Show by calculation the amount of steam required for a 100-horsepower hoisting engine running at a speed of 150 revolutions per minute, and cutting off steam at $\frac{1}{2}$ -stroke, when the boiler pressure is 85 pounds, the ratio of the length of stroke to the diameter of piston being $r = 1.5$. Show how the consumption of steam is determined when the indicated horsepower and the mean effective cylinder pressure are known.

QUES. 688.—*Cost of Tipple at a Shaft Mine*.—Make an estimate of the cost of a tipple or dump at a bituminous shaft mine where 1,000 tons of coal are hoisted per day. The estimate will include the timber, iron, and all materials necessary for the building, and the cost of erecting the same. Make a sketch showing the plan and sectional elevation of the tower, dump, screens, engine brace, rock dump, and all accessories for loading and shipping three grades of coal, lump, nut, and steam coal. The floor of the dump is to be 26 feet above the top of rail, and the loading tracks are 12 feet, center to center. The estimate will not include the hoisting engine or track scales. Give bill of material, assuming prices for all labor and material.

QUES. 689.—*Parting an Assay*.—Explain what you understand by the term "parting an assay". Describe the method of parting an assay (a) When the ore is a gold ore containing some silver, (b) When the ore is a silver ore, the amount of gold present being small.

QUES. 690.—*Splitting, Natural Division of Air*.—(a) Calculate the natural division of 150,000 cubic feet of air between the following splits:

Split A, 8 ft. $\times$ 9 ft., 4,000 feet long,

Split B, 6 ft. $\times$ 9 ft., 3,500 feet long,

Split C, 8 ft. $\times$ 12 ft., 5,000 feet long.

(b) Where should regulators be placed in order to accomplish the following division of air in these airways: Split A, 75,000 cubic feet, split B, 45,000 cubic feet, split C, 30,000 cubic feet? (c) Calculate the size of the opening in each regulator.

QUES. 691.—*Barometric Elevations*.—If the reading of the barometer at station a is 29.52 inches and the temperature 60° F., determine the height above this point, of station b, where the barometer reads 27.35 inches, the temperature being 48° F.

Answers to Questions Which Appeared in the April and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 656.—*Form and Number of Fan Blades*.—What in your experience is the best form of fan blade for closed fans? State what determines the number of blades to be used in a fan.

Ans.—The straight paddle-blade [normal to the outer circumference but] with Guibal lip is now generally acknowledged to be the best form of fan blade for closed fans. [The blades should not be tapered toward the circumference in closed fans.] The number of fan blades to be used in a fan depends on the size of the fan and the speed of its revolution, high-speed motors requiring a less number of blades than low-speed motors. To obtain the best results, the air at the circumference of the fan must be fully supported and pressed forward. As few blades as are necessary to accomplish these results should be employed since an increase in the number of blades means a corresponding increase in the resistance to the air current. The distance between the blade tips may be from 1 to 3 times the depth of the blade, but should in no case exceed 10 or 12 feet. Small blades, running inward only half as far as the other blades are sometimes introduced at the circumference between the larger blades, with the result that, while giving the air at the circumference an increased support, they do not materially augment the friction at the inlet of the fan.

THEODORE SIMONS, Spokane, Wash.

Second Prize.—CHAS. E. BOWEN, Birmingham, Ala.

QUES. 657.—*Calculation of Size of Fan Required for a Given Circulation*.—What size of fan would you employ for the circulation of a volume of 150,000 cubic feet of air per minute against a water gauge of 2 inches?

Ans.—We will assume that it has been decided to employ a straight paddle-blade fan, with curved Guibal lip [spiral casing and double intake opening], and that the area of the fan drift, where the water gauge is read, is equal to 75 square feet, giving a velocity at this point of $v = \frac{150,000}{75} = 2,000$ ft. per min. The three distinctive dimensions, governing the design of a fan, are:

- (1) the outer diameter D of the fan blades,
- (2) the breadth b of the fan,
- (3) the expansion e of the casing at the point of cut-off.

To calculate these dimensions, we first have to ascertain the values of the potential $X = \sqrt{\frac{Q^2}{P}}$, the efficiency K , and the ratio between the outer and inner radii or diameters $m = \frac{R}{r} = \frac{D}{d}$.

The following calculations are based on the formulas explained in the article by J. T. Beard in the September, October, and November numbers of MINES AND MINERALS, 1899, which are as follows: [see also Coal and Metal Miners' Pocketbook, 6th edition, pages 390-391.]

$$K = \frac{163,600^2}{c X^3 + 163,600^2} \quad (1)$$

$$m = \sqrt[n^2 \sqrt{V}]{\frac{Q}{c} \left(c + \frac{163,600^2}{X^3} \right) + 1} \quad (2)$$

$$D = \frac{m}{\sqrt{m^2 - 1}} \cdot \frac{3,770 \sqrt{p}}{n \sqrt{K^2 V}} \quad (3)$$

$$b = \frac{D}{1.6 m} \quad (4)$$

$$e = \frac{Q}{\pi D b n} \quad (5)$$

$$d = \frac{D}{m} \quad (6)$$

in which Q = quantity of air (cu. ft. per min.) 150,000;
 n = speed of rotation (rev. per min.) 100 (assumed);
 p = unit of ventilating pressure (lb. per sq. ft.)
 d = diameter of intake orifice (ft.);
 c = constant of design, for this case assumed as 4.

Substituting values, we have, since $2 \times 5.2 = 10.4$ lb., and

$$X^3 = \frac{150,000^2}{10.4},$$

$$(1) \quad K = \frac{163,600^2}{4 \frac{150,000^2}{10.4} + 163,600^2} = \frac{1}{4 \times .0808 + 1} = 75.6 \text{ per cent.}$$

$$(2) \quad m = \sqrt{\frac{150,000}{100^2 \sqrt{2,000}} \left(4 + \frac{163,600^2}{150,000^2} \right) + 1} = 1.865.$$

$$(3) \quad D = \frac{1.865}{\sqrt{1.865^2 - 1}} \frac{3,770 \sqrt{10.4}}{100 \sqrt{0.756^2 \times 2,000}} = 16.65 \text{ ft.}$$

$$(4) \quad b = \frac{16.65}{1.6 \times 1.865} = 5.58 \text{ ft.}$$

$$(5) \quad e = \frac{150,000}{3.1416 \times 16.65 \times 5.58 \times 100} = 5.14 \text{ ft.}$$

$$(6) \quad d = \frac{16.65}{1.865} = 8.93 \text{ ft.}$$

The dimensions of the fan casing are governed by the values of D , b , and e ; from the cut-off the area of the air conduit should increase uniformly to the top of the downcast shaft, avoiding sharp angles, and at this latter point the sectional area of the air conduit should equal the area of the shaft. The cut-off itself should be a sharp line, and should, for a short distance on either side of the cut-off, form a lining to the fan casing and the air conduit. From beyond the cut-off the expansion of the air conduit should not be too slow, but must be regular to avoid baffles and eddies. [See answer to P. C. Ques. 648, page 456, MINES AND MINERALS, May, 1901.]

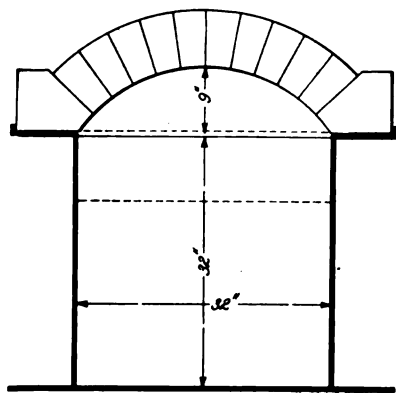


FIG. 1.

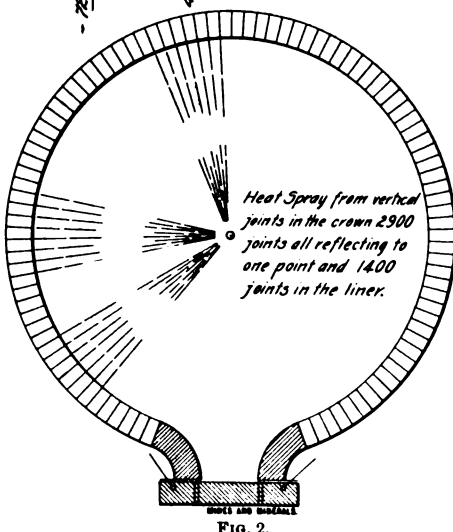
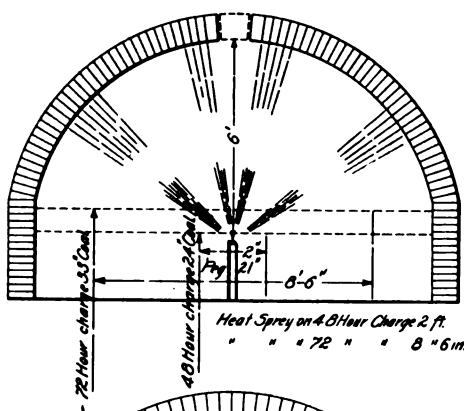


FIG. 2.

section at the door of the oven. The door is a very essential part of the oven and is 32 inches square, open at the top. Over the door is a brick arch having a 9-inch spring. The door is made as small as is practicable for a 12-foot oven, and is then more convenient both with respect to bricking and daubing as well as ventilating, the 9-inch arch-opening above giving a good distance over the charge of coal for ventilation without cutting or wasting

the coal. Fig. 2 is a vertical section and plan showing the arrangement of the bricks and joints of the plumb wall or liner. All of these joints radiate from a common center, as do also the joints of the crown arch above the oven. The light lines represent the heat reflected toward the center of the oven by the walls and the filling in around the liner. Fig. 2 also shows a cross-section through the center of a beehive coke oven, 12 feet in diameter, and 7 ft. 9 in. in the clear under the crown arch, with a plumb wall 3 feet high. A peg 21 inches high has been used for carrying the center of the arch or dome, the radius of which is 6 feet, the arch being a section of a sphere. The essential features of this oven are as follows: (1) A plumb wall of 36 inches, fitting the oven both for a 48-hour charge of 24 inches of coal or a 72-hour charge of 33 inches of coal. (2) A truly spherical arch or dome reflecting the heat to a common center. Coke making in a beehive oven begins on the top of the charge of coal and burns downward. It will be seen from the sketch that a 48-hour charge 24 inches deep, receives the direct radiation from the arched roof in a circle whose diameter is only 2 feet, while the radiation upon a 72-hour charge 33 inches deep, makes a circle whose diameter is 8 ft. 6 in., as shown in the sketch. This form of oven gives room for the drawer to break down the coke with the scraper on a 72-hour charge without coming in contact with the crown or arch of the oven. Also, the arch or crown is not wet when watering out the coke. An oven of this size properly constructed with a good filling will burn off an ordinary 48-hour charge in 38 hours, thereby effecting a saving of 10 hours. W. T. GATES, Simpson, W. Va.

Second Prize.—F. J. HARVEY, Hostetter, Pa.

Ques. 668.—Working an Ore Chimney.—Describe how you would work a nearly vertical ore chimney extending downward from the surface. The ore is an extremely high-grade mineral, which makes its complete extraction essential. The country rock of the adjoining strata is not wholly self-supporting; it does not crumble but has a tendency to break in large pieces. The ore chimney is elliptical in cross-section, its smaller diameter averaging 18 feet while the larger diameter will average 30 feet. Describe particularly the methods of extraction and timbering that will render the working of this ore body safe, and will permit of the entire extraction of the mineral.

Ans.—Let $ABCD$ (Fig. 3) be a general cross-section of the ore chimney. A shaft is sunk in the country rock on the lower side of the ore body, or so that the chimney will bear away from the shaft as the depth increases. The shaft must be of a size sufficient to deal with the output, water, etc. At different levels drifts or adits are driven to the ore body, the size of these drifts or adits being, say 7 ft. $\times$ 7 ft. They are driven through the ore body until the opposite wall of the chimney is reached, and timbered as required. At the center of the ore body two cross-drifts are turned to the right and left at right angles to the main tunnel as shown in the figure, and driven to each wall or rock. An upraise is then started at the center and an ore chute and manway put in. If not timbered before, the timbers should now be put in place using square sets with mudsills of the following sizes: mudsills 8 in. $\times$ 10 in., posts 10 in. $\times$ 10 in., caps 10 in. $\times$ 10 in. or 12 in. $\times$ 10 in. and sprags 10 in. $\times$ 10 in. The lagging should be strong but not close, being used against the walls, and all vacant spaces being filled with waste. When the tunnels are secure the material at each side and above is excavated by regular overhand stoping, the timbering being carried on as the work advances until the whole section is extracted to the level above. Care must be taken to lag the timbers and make the outer walls secure by packing all empty spaces behind the lagging with waste [which must be brought from the surface if necessary. See page 558, MINES AND MINERALS, July, 1898.] C. D. WRAY, Lillooet, B. C., Canada.

Ques. 659.—Form and Dimensions of Coke Ovens.—Make a sketch showing the best form of coke ovens, and giving the important dimensions of the same.

Ans.—An experience of twenty years leads me to believe that the best style and dimensions of ovens for the many different coals is what is known as the beehive oven built in blocks back to back, 14 feet from center to center, with a 2 ft. $\times$ 7 ft. stone pillar for a larry track. The 14 feet center to center for an oven 12 feet in diameter allows 6 inches of filling between ovens at the closest point, which is very essential as a retainer of heat. Fig. 1 is a cross-

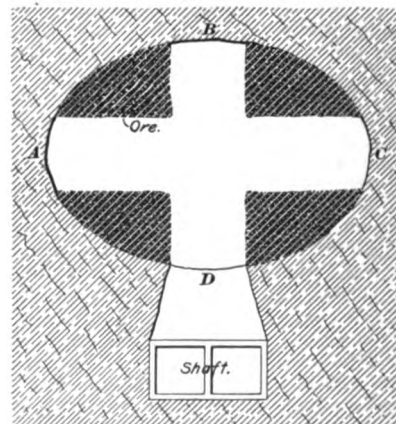


FIG. 3.

Second Prize.—W. H. SHERBURNE, Cripple Creek, Colo.

Ques. 669.—Sinking Through Swelling Ground.—Describe how you would timber a shaft, in sinking through strata that swell, in order to avoid future trouble and annoyance in the operation of the mine.

[This is a practical question calling for experience in shaft sinking and timbering. The question still remains open.—EDITOR.]

Ques. 672.—Surveying for Mine Opening.—A coal seam outcropping on a side hill has a dip of 3° , the direction of the dip being $N 80^\circ 30' E$. This seam was formerly worked from a drift driven in upon the seam from the outcrop, the direction of the drift being $N 75^\circ 20' W$. At a point farther around the hill from the drift opening there is a favorable location for the tippie and side tracks necessary for a large mine; and it is proposed at this point to drive a rock slope having an inclination of 20° , in a direction corresponding to the strike of the seam or $S 9^\circ 30' E$. In order to make this opening as rapidly as possible, the work is to be pushed from both ends, and it is therefore desired to know the point along the drift, at which a level road should be started, in order to meet the foot of the slope where the latter strikes the seam. To determine this the following survey was made from the mouth of the proposed opening around the hill to the mouth of the old drift:

Sta.	Deflection Angle.	Vertical Angle.	Distance (feet).	Sta.	Remarks.
1		$-15^\circ 30'$	310	2	{ Sta. 1 at mouth of slope.
2	R $24^\circ 30'$	$-15^\circ 20'$	400	3	
3	R $40^\circ 25'$	$-9^\circ 30'$	250	4	
4	L $62^\circ 30'$	$+5^\circ 00'$	190	5	
5	R $85^\circ 20'$	$+10^\circ 20'$	560	6	{ Sta. 6 at mouth of drift; Foresight on line of drift.
6	R $123^\circ 20'$				

(a) Determine the distance from mouth of drift (Sta. 6) to center line of level road running to meet the slope. (b) Determine the length of the level road from the center line of the drift to the foot of the slope. (c) Determine the length of the slope from station 1, to its foot where it meets the level road.

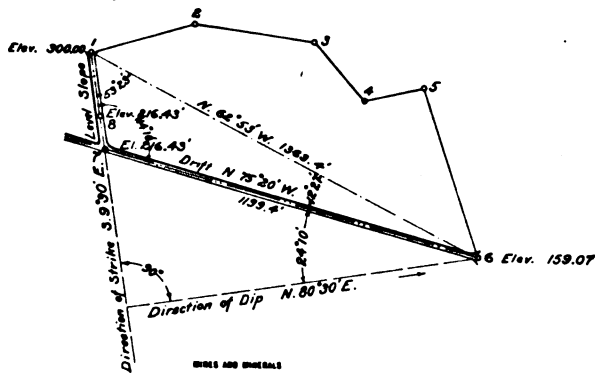


FIG. 4.

Ans.—Let Fig. 4 represent a plan of the survey, showing also the drift (6-7) upon the seam, and the proposed rock slope (1-8) having an inclination of 20° , and the level road (8-7) in the seam; the slope being driven in the direction of the strike of the seam must form a straight line with the level road driven from the foot of the slope in the seam. To determine the distances 6-7, 7-8, and 1-8, we will first traverse the survey as follows, assuming for Sta. 1 an elevation of 300 feet above datum:

Sta.	Bearings.	Vertical Angle.	Slope Distance.	Horizontal Distance.	Vertical Distance.	Latitudes.		Departures.	Elevation.
						N	S		
1	N $73^\circ 35' E$	$-15^\circ 30'$	340	327.68	90.86	92.60		814.27	300.00
2	S $81^\circ 55' E$	$-15^\circ 20'$	400	379.70	125.82			875.93	209.14
3	S $41^\circ 30' E$	$-9^\circ 30'$	250	246.57	41.26		58.39	163.38	83.32
4	N $76^\circ 00' E$	$+5^\circ 00'$	190	189.28	16.66	45.79	184.67	183.66	42.06
5	S $18^\circ 40' E$	$+10^\circ 20'$	560	550.92	100.45			176.33	58.62
6	N $75^\circ 20' W$						521.94		159.07
Totals						138.39	760.00 188.39	1213.57	
Difference in latitude						621.61		1,213.57	
Difference in departure									

We next find the bearing of closing line 6-1 of the survey by dividing the difference in latitude by the difference in departure, thus, $\tan a = \frac{1,213.57}{621.61} = 1.9523$, and $a = 62^\circ 53'$. Hence, bearing of line 6-1 = $N 62^\circ 53' W$, and distance = $\frac{1,213.57}{\sin 62^\circ 53'} = 1,363.4$ ft.

From the horizontal triangle 1-6-7 we find the distance $6-7 = 1,363.4 \times \frac{\sin 53^\circ 23'}{\sin 114^\circ 10'} = 1,199.4$ ft.

$$1-7 = 1,363.4 \times \frac{\sin 12^\circ 27'}{\sin 114^\circ 10'} = 322.4 \text{ ft.}$$

Referring to formula given in answer to Ques. 590, page 25, MINES AND MINERALS, August, 1900, we have percentage of the grade of the drift $6-7 = 100 \times \cos 24^\circ 10' \times \tan 3^\circ = 4.78$ per cent. Hence, difference of elevation between Sta. 6 and Sta. 7 = $1,199.4 \times .0478 = 57.35$ ft. and elevation of Sta. 7 and Sta. 8 above datum = $159.07 + 57.35 = 216.42$ ft.

The difference in elevation between Sta. 1 and Sta. 8 is $300 - 216.42 = 83.58$ ft., and the slope between Sta. 1 and Sta. 8 being 20° , we have for the length of slope $\frac{83.58}{\sin 20^\circ} = 244.38$ ft.

The horizontal length of the slope, $\frac{83.58}{\tan 20^\circ} = 229.6$ ft. Subtracting this distance from the length of the line 1-7 (322.2 feet), we have for the length of the level road, 7-8, $322.2 - 229.6 = 92.6$ ft.

THEODORE SIMONS, Spokane, Wash.

Second Prize.—W. F. HUGHES, Wilkes-Barre, Pa.

Ques. 670.—Direction of Driving Gangways and Rooms in an Inclined Seam.—A seam of coal has a uniform easterly dip of 10° . The strike of the seam is $N 15^\circ 30' W$, or $S 15^\circ 30' E$; the cleats of the coal are not so pronounced as to affect the direction in which the rooms should be driven. Give the direction of the main slope and the gangways or haulage roads, and the direction of the rooms that would afford the most economical handling of the coal from the face to the shaft bottom.

[This question is still open.—EDITOR.]

Ques. 671.—Ventilation Deranged.—If the ventilation of a mine has been deranged by the accidental setting open of a door, explain why the fire boss should not make the regular inspection of the workings until the ventilation has been restored; and how he should then proceed.

Ans.—Article 20, Rule 9, of the Bituminous Mine Law reads as follows:

He (the fire boss) shall enter the mine before the men have entered it, and before proceeding to examine the same he shall see that the air current is traveling in its proper course, and if all seems right he shall proceed to examine the workings.

The fire boss should therefore give his first attention to the air current for the reasons: (1) The door being left open would leave some portions of the mine without air, and gas might accumulate in large quantities. (2) When ventilation is first restored to its proper course this gas would diffuse rapidly and mix with the air to such an extent as to form dangerous bodies of firedamp. (3) The gas would accumulate in large quantities in all of the higher workings, inbye from the point where the door was left open. The fire boss on finding a door open should proceed cautiously to first examine the workings from which the air has been cut off by reason of the door being open, to ascertain if there has been any accumulation of gas as a result. He should make this examination as far as practicable before shutting the door, and, having satisfied himself by such examination in regard to the condition of the workings and the amount of gas accumulated, use his best judgment. If there is much gas present he should carefully consider means of conducting it in the most direct manner possible to the return airway, so that it will not pass through other sections of the mine. [The door must be closed cautiously and only after making sure that there are no men working upon the return current;] and the examination must continue in this manner with the air current. JAS. STEVENSON, Thurber, Pa.

Second Prize.—JOHN McCLANE, Whitney, Pa.

Ques. 673.—Spontaneous Combustion as Causing Gob Fires.—Explain as clearly and concisely as possible the conditions and reactions that cause spontaneous combustion in the gob and waste places of mine, and result in gob fires.

Ans.—Conditions.—The oxygen of the air is brought into close and intimate relationship with the combustible matter of the coal by absorption in the pores of the coal. The presence of moisture promotes this condition and assists the chemical action which follows.

Reactions.—The absorbed oxygen unites chemically with the constituents of the coal (the carbon and hydrocarbons) resulting incidentally in a rise of temperature, oxidation of the carbon and the setting free of gaseous hydrocarbons. These reactions assisted by the presence of the moisture cause [the rapid disintegration of the coal which again promotes the conditions giving rise to] the spontaneous ignition first of the gases produced and then of the fine particles of coal. JOHN McCLANE, Whitney, Pa.

Second Prize.—CHARLES SEBASTIAN, Freeburg, Ill.

Ques. 674.—Steel vs. Wooden Mine Cars.—What are the advantages and disadvantages of using steel mine cars instead of wooden ones?

Ans.—For the same capacity, steel cars are lighter than

wooden cars, giving an increased ratio of *live to dead load*; [they dump more freely and quickly, and do not scatter the fine coal and dust along the road in hauling].

The first cost of steel cars is 50 per cent. greater than that of wooden cars, to compensate for which there should be likewise an increase of 50 per cent. in the life of the car, and the cost per car for repairs should be for steel cars $\frac{1}{2}$ of what it is for wooden cars. In practice this is not the case, for the sulphur and other mineral waters present in most mines attack the metal, particularly around seams and rivets, making the car short-lived. Renewing steel parts of a wooden car is only a matter of taking out a few bolts, but in a steel car rivets must be cut. Wooden sides are easily replaced, but steel sides require specially cut plates, punched or drilled and then riveted, which is something for which the ordinary mine repair shop is not equipped. In case of a trip being wrecked, where wooden cars would be smashed, steel cars are so bent as to be worth little above the cost of repairs and such a wreck is harder to handle.

FRED D. BUFFUM, Monongahela, Pa.

Second Prize.—R. ZERUBBABEL VIRGIN, Punxsutawney, Pa.

QUES. 675.—*Size of Exhaust Steam Line.*—(a) Calculate the size of an exhaust steam line having a 125-horsepower haulage engine (duplex), the exhaust from the engine being carried into a feedwater heater in the boiler room. (b) What should be the size of the steam pipe supplying steam to this engine.

Ans.—(a) Assume that this engine uses 35 pounds of water or steam per horsepower per hour; then $\frac{35 \times 125}{60} = 72.9$ lb. per min.

As the engine exhausts into a feedwater heater the back pressure will probably be, say 6 pounds, or $6 + 15 = 21$ lb. absolute. At this pressure 1 pound of steam has a volume of about 19 cubic feet. If we take the allowable velocity at 6,000 feet per minute [it is better to assume a velocity of 4,000 feet per minute in the exhaust pipe] the area of the exhaust pipe should be $\frac{19 \times 72.9 \times 144}{6,000} = 33.24$ sq. in., corresponding to a pipe about

6 $\frac{1}{2}$ inches in diameter. (b) If the boiler pressure be 80 pounds ($80 + 15 = 95$ lb. absolute), 1 pound of steam will then have a volume of 4.56 cubic feet. Hence, the area of pipe supplying steam to each cylinder is $\frac{4.56 \times 72.9 \times 144}{6,000} = 7.9$ sq. in., corresponding to a pipe about 3 $\frac{1}{2}$ inches in diameter. In practice we would make the main steam pipe, say 4 $\frac{1}{2}$ inches, with a 3 $\frac{1}{2}$ -inch branch to each cylinder, and the main exhaust 8 inches, running a 5-inch branch from each engine.

CHAS. E. BOWEN, Birmingham, Ala.

Second Prize.—CHAS. P. MCGREGOR, Bridgeville, Pa.

[The above general solution assumes a steam consumption of 35 pounds of steam per horsepower per hour. As a matter of fact this is too large an amount for one cylinder under ordinary conditions. Dry steam consumption per cylinder (pounds per horsepower per hour) depends primarily upon three factors: (1) *initial cylinder pressure*, (2) *point of cut-off*, (3) *piston displacement per hour*. Allowance must also be made for condensations in pipes, valves, and cylinder. It will be interesting to consider this further. See Ques. 687.—EDITOR.]

Convention of the National Association of Manufacturers.

President Theodore C. Search, of the National Association of Manufacturers, announces that the Executive Committee has selected the dates of June 4, 5, and 6 for the holding of the sixth annual convention of the Association, which will meet in Detroit. These dates, which are somewhat later than the usual time of holding the annual convention, were chosen in order to secure the advantages of a more favorable season in Detroit than would be found in January, during which month the conventions have usually been held heretofore. Mr. George H. Barbour, of Detroit, the Michigan Vice-President of the Association, is in general charge of the arrangements in Detroit.

The opening of the Pan-American Exposition at Buffalo a few weeks prior to the dates fixed for the convention will enable manufacturers to arrange for a trip which will take in both points of interest. It is expected that arrangements will also be made for excursions to points of interest on the lakes after the adjournment of the convention, so that the program of the convention week this year will offer more than the usual attractions for those who desire to combine business and pleasure in their attendance at the convention.

On the recommendation of the Franklin Institute, the silver medal and diploma was awarded by the National Export Exposition to The International Correspondence Schools, Scranton, Pa., for a unique, thorough, and comprehensive system of technical education by correspondence.

MANOMETRICAL EFFICIENCY.

The Term Applies to the Efficiency of a Given Circulation and Does Not Express the Efficiency of a Fan.

Written for MINES AND MINERALS, by J. T. BEARD, C. E., E. M.

The meaning and scope of the term manometrical efficiency, is often very much misunderstood. As employed in mining practice, a greater importance is usually attached to the term, and a broader significance given to its meaning than is warrantable. To illustrate, suppose a fan operated at a given mine is found to give a manometrical efficiency of 50 per cent. One is naturally led by such a statement to suppose that this fan represents a general type of construction that will yield a manometrical efficiency of about 50 per cent. wherever it may be placed; or in other words, that the term manometrical efficiency as here used, has reference to the fan only. To remark that this efficiency has a particular reference to the mine potential* or the conditions of resistance in the airway, would perhaps surprise many who have not given the subject careful thought.

Our meaning will be made clearer by referring to the circulation given in Examination Ques. 9, page 516. In the solution of this question it has been calculated that a 14-foot fan having an efficiency of 50 per cent., and running at a speed of 111.66 revolutions per minute, will produce a water gauge of 1.5 inches in a certain mine, and incidentally a circulation of 120,000 cubic feet of air results in the mine airways. Now, assuming this to be the case any change in the conditions of resistance in the airway will affect the speed and power of the fan only incidentally, while the quantity and pressure of the circulation vary inversely as each other, but since for a constant power the quantity of air in circulation is proportional to the potential, the pressure varies inversely as the potential, and in general, it may be stated that *at the same speed of rotation of the fan the water gauge reading will vary inversely as the potential of the airway*. It is thus evident that this fan may be operated at another mine where at the same speed and power it will yield a water gauge of say 2 inches, producing a circulation of 90,000 cubic feet of air per minute. But while the manometrical efficiency of the fan at the first location was 50 per cent. ($\frac{1.5}{3.0} \times 100 = 50$) it is now 66 $\frac{2}{3}$ per cent. ($\frac{2.0}{3.0} \times 100 = 66\frac{2}{3}$). This example shows clearly that this term applies to the *efficiency of the circulation* more particularly than to that of the fan.

In order that the term efficiency shall properly apply to any machine, it must relate to that machine when working under all conditions. Speaking with reference to the fan alone, the result of rotating a given fan at a fixed speed is not a fixed result as regards either quantity or pressure, since a varying quantity and pressure result dependent upon the conditions of resistance. For example, the fan may discharge into free air when a large volume and no pressure will result; increasing the resistance to the discharge decreases the volume and increases the pressure. If the discharge is made into a closed space, no volume but the highest possible pressure (static pressure) is the result. There are thus, three cases. (1) Discharge into free air when the head due to the action of the fan is wholly converted into a velocity head, as given by the equation $h = \frac{v^2}{2g}$. (2) Discharge into an airway

when the head due to the action of the fan is converted partly into a velocity head and partly into a friction head due to the resistance of the airway. (3) Discharge into a closed space when the entire head is converted into a static pressure. The second case mentioned is of most importance in mine ventilation. The question of efficiency in this case should relate to the ratio that the *effective power* bears to the *theoretical power*, and not the ratio between the effective and theoretical pressures as is contemplated in manometrical efficiency, for the reason, as shown above, that the ratio of pressures is not a fixed ratio for a given fan but only for a given circulation or airway. It is true that for the same circulation the ratio of pressures is equal to the ratio of the powers, but this is one case only, and the efficiency obtained does not refer to the fan itself or as we say *per se*. We observe, therefore, that every circulation has an efficiency of its own. As in the compression of air the conditions relative to the initial and terminal pressures determine an efficiency that pertains to that compression, so in ventilation every circulation possesses an efficiency peculiar to itself, and which affects unavoidably the true efficiency of the machine. Thus, the compression of air from atmospheric pressure at sea level, to a gauge pressure of 100 pounds per square

*The potential of any given circulation is the ratio between the quantity of air in circulation and the cube root of the power producing the circulation $\frac{A}{P} = \frac{3}{\sqrt[3]{Q^2}}$. The value of this ratio in terms of the airway is $\frac{a}{\sqrt[3]{k}}$, which is the potential of the airway (See Coal and Metal Miners' Pocketbook, 6th Edition, page 367.)

inch, is accomplished only with a loss of, say 58 per cent. of the power of compression, giving an efficiency of 42 per cent. for such compression, aside from the efficiency of the machine. The circulation of 120,000 cubic feet of air per minute under a water gauge of 1.5 inches is likewise performed only at a given percentage of loss, and an efficiency thus attaches to each circulation peculiar to itself. The circulation of the same quantity of air under a higher water gauge will always present a higher efficiency. This will be clearer as we proceed.

We can now understand as perhaps we did not before, that in order to evaluate the work of a given type of fan we must be able to separate its efficiency as a machine from the modifying efficiency of the circulation which it is compelled to perform. Thus, a fan that is required to circulate 120,000 cubic feet of air per minute under a water gauge of 1.5 inches would be doing good work if it presented an efficiency of, say 78 per cent., while the same type of fan circulating the same quantity of air under a water gauge of 3 inches, might be expected to give an efficiency of, say 88 per cent. We can thus realize how important it is that any expression giving correctly the efficiency of a fan *per se*, must be modified by the factors of the circulation.

Here is a simple proposition.

Let K = the efficiency of a fan *per se* $\left(\frac{Qp}{U}\right)$;
 U = the total power of the fan, including the power absorbed within itself (ft.-lb. per min.);
 u_1 = the power lost in the fan (ft.-lb. per min.);
 Q = quantity of air in circulation (cu. ft. per min.);
 p = unit of ventilating pressure (lb. per sq. ft.);
 X = potential of the circulation $\left(X^2 = \frac{Q^2}{p}\right)$;
 c = constant determined by type of construction of the fan.

Then, $K = \frac{\text{effective work}}{\text{total work}} = \frac{U - u_1}{U} = 1 - \frac{u_1}{U}$.

But $KU = Qp$, and $u_1 = cQ^2$, since the work lost within the fan depends upon the cube of the quantity of air passing;

then, $\frac{u_1}{U} = cK \frac{Q^2}{p} = cKX^2$.

Now, substituting this value in the first equation above, expressing the value of K , we have,

$$K = 1 - cKX^2,$$

and $K = \frac{1}{1 + cX^2}$.

This expression for the efficiency of a fan is more rational, as it contains the factors of the circulation to be accomplished. (See Coal and Metal Miners' Pocket Book, 6th Edition, page 390.)

The question of fan ventilation is one of producing a given velocity in an airway under a given ventilating pressure. More practically stated, the question concerns the application of a given power to produce a given velocity in an airway. The resistance of the airway establishes the pressure, and in connection with the power applied determines the velocity of the air current, the quantity being determined by the sectional area of the airway. It is gross assumption to suppose that a given tip-speed of a fan will give a fixed water gauge under all conditions. This is the same as asserting that the conditions of discharge do not affect the water gauge given by a fan at a fixed speed, or saying that if a fan is run at a constant speed the closing off of the mine or airway will not cause a rise in the reading of the water gauge. Any change in the mine potential or potential of the airway (X), when the power upon the air (KU) is constant, will produce a like change in the quantity of air in circulation, and an inverse change in the pressure or water gauge reading, as is evident from an inspection of the elemental equalities

$$KU = Qp = \left(\frac{Q}{X}\right)^2.$$

And, hence, the usual formula $h = \frac{u^2}{g}$ that makes the pressure,

water gauge, or air column (h) a function of the tip-speed (u) of the fan, is not a general formula, but applies to a single circulation only. In summing up, let us emphasize the fact that what is known as the mechanical efficiency of the fan, or the ratio between the effective and theoretical powers represents the work of the fan more correctly, and is of more importance than the manometrical efficiency. The mechanical efficiency, however,

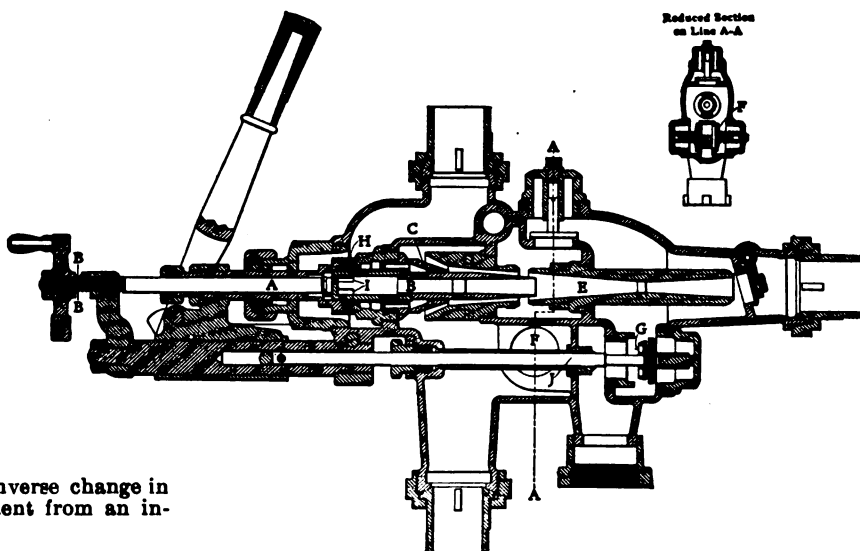
should not be understood as being the percentage of the indicated horsepower of the fan engine that becomes effective upon the air. This has been its usual interpretation, but this practice confuses the efficiency of the engine and that of the fan. When possible, the engine should be run at a given speed under no load and the efficiency determined, and a proper allowance made for this from the power of the engine card in assuming the efficiency of the fan; or a rational formula expressing as nearly as possible the theoretical work of the fan should be the assumed basis. In this manner only can we hope to attain to greater perfection in the design of ventilators.

The Lunkenheimer '89 Model Standard Injector.

Herewith is shown a sectional view of the new injector which the Lunkenheimer Company, of Cincinnati, Ohio, recently placed upon the market. The construction of the machine is novel in a number of particulars, and differs essentially from any of those now on the market.

Referring to the cut it will be noted that by pulling the lever slightly the steam valve H is withdrawn from its seat and steam is admitted to the lifting steam jet C , through the annular space around the movable steam tube B . Steam flowing into water lifting tube B forms a vacuum in the water supply pipe, and the water is "lifted" and passes out through check valve A , also delivery tube E , past the overflow valve G to the atmosphere. Drawing the handle farther back opens the ports $I-I$ in movable steam tube B , thus admitting steam to the interior of said tube, which forces the water through combining tube E past line check to boiler, due to the closing of overflow valve G , occasioned by withdrawal of rod J . The principal feature in this machine is that the regulation of the water is accomplished by the movement of the movable steam tube B , the amount of which is controlled by the crank handle at the end of the machine. On this account it differs from all other forms of injectors inasmuch as, in cutting down the discharge of water, the steam consumption is reduced in direct proportion. In all other forms of injectors the steam supply remains constant, while the water supply alone is reduced.

The manufacturers claim for the injector that it will start promptly under most conditions and can be depended upon to work reliably at all steam pressures from 25 to 300 pounds, and higher. They further claim that it is distinctively a high-pressure injector, designed particularly for that service. It is also self-adjusting—that is to say, it is not affected by variations of steam pressure, even within great limits; and when started, for instance, at 70 pounds, it can be relied upon to work uninterruptedly to 300 pounds, and a sudden reduction in pressure would not disturb its action. There are a number of mechanical advantages about the



injector, such as easiness of making repairs and other details, and the manufacturers will be pleased to send a complete descriptive circular upon application.

Mr. George E. Roberts, Director of the Mint, Washington, D. C., estimates that during 1901 the world's gold output will be \$1,000,000 per day, or \$365,000,000 for the year. As the estimate for 1900 is of \$257,000,000, of which Africa furnished only a very small portion of its possible quota, the figures of the director of the mint do not seem at all optimistic.

Calkins' Gyratory Muller for Reducing Crushed Ore Samples to Pulp for Assayers and Chemists.

A satisfactory laboratory pulverizer or muller has long been sought for by chemists and assayers. F. W. Braun & Co., of Los Angeles, Cal., a short time ago put on the market the Calkins gyratory muller, here described, and the immediate and favorable reception given it by those in charge of laboratories and assay offices proved its worth.

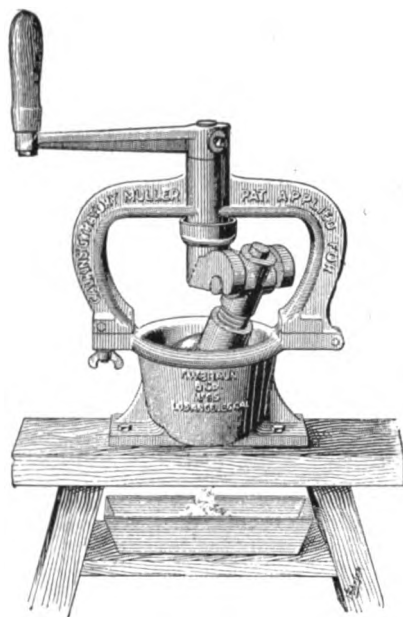


FIG. 1.

This gyratory muller is designed to pulverize ore samples to any desired degree of fineness, such samples having previously been crushed in a rock breaker or ore crusher.

It consists of an iron mortar having an opening or discharge outlet in the bottom, and a round iron ball or pestle, the contour of which conforms exactly to the entire bottom of the mortar. About one-sixth of the area of the ball comes in actual contact with the bottom of the mortar when no substance intervenes; this construction gives the maximum amount of grinding surface.

The machine is operated by turning a handle which is supported by a bale or arch over the mortar. A right angle clutch extension attached to the shaft of the handle imparts a gyratory and rotary motion to the ball. The right angle extension of the rotary shaft clutches a box fitted to the shaft in the ball which forces a gyratory motion, yet allows the metal being crushed to produce by attrition a revolution of the ball in an opposite direction to the way it is being gyrated. This peculiar motion effects a twisting, crushing and grinding, and prevents the material being pulverized from being thrown ahead of the ball by centrifugal force. This is the most important feature of this appliance. A destructive movement is obtained and the material forced to discharge through the opening in the bottom.

Tight engagement between the ball and the mortar is obtained by a coil spring around the shaft, which at its lower end presses

screw at the opposite side which permits the entire inside to be easily accessible for cleaning by swinging the bale over as shown in Fig. 2, which allows the ball to be readily lifted out.

The difference between this and the radial bucking plate is, that to pulverize the ore samples to extremely fine powders it is necessary to feed and refeed perhaps several times, according to the character of the material being run.

It is claimed that this machine is unequaled where large or small quantities of ore are to be pulverized to a given size; as the product of each feeding is exactly uniform in size, which is not the case with any other device on the market. Parts of the product of any bucking plate must necessarily be an impalpable powder, this is detrimental to an accurate determination of the leaching qualities of any ore, which is one of the preliminary tests in any leaching process.

This machine is also made with removable plug shown in sectional drawing at lower right hand corner of Fig. 2 which is a perfect amalgamating mortar. Either style can be furnished geared to vertical flywheel instead of handle, so that they may be operated by power.

The greatest width is 16 inches; greatest height is 13 inches; diameter of ball, 5 inches; net weight, 61 pounds; weight packed for shipment, 86 pounds.

The capacity when operated by power is about 1 pound per minute. With ore of average hardness about 75% of first feeding will pass a 60-mesh screen.

The Allis-Chalmers Company.

A consolidation of some of the leading manufacturers of engines and mining machinery has been finally effected, negotiations having been in progress for more than two years past.

The new organization which was recently effected in Chicago is known as the Allis-Chalmers Co., and comprises the E. P. Allis Co., Milwaukee, Wis.; Fraser & Chalmers, Chicago; the Gates Iron Works, Chicago; and the Dickson Mfg. Co., Scranton, Pa., exclusive of the locomotive works of this latter company, which are not included in the consolidation. The new company has been organized under the laws of New Jersey, having an authorized capital stock of \$25,000,000 preferred and \$25,000,000 common, of which \$16,250,000 preferred and \$20,000,000 common will be issued.

The directors of the new company are as follows: Edward D. Adams, New York; Chas. Allis, Milwaukee; Mark T. Cox, Orange, N. J.; James H. Eckels, Chicago; Elbert H. Gary, New York; William A. Read, New York; Jas. Stillman, New York; William W. Allis, Milwaukee; Frank G. Bigelow, Milwaukee; W. J. Chalmers, Chicago; Wm. L. Elkins, Jr., Philadelphia; Henry W. Hoyt, Chicago; Max Pam, Chicago; Edwin Reynolds, Milwaukee; and Cornelius Vanderbilt, New York. The offices will be in Chicago and the new company will take over the current business of the several companies included in the deal as on hand April 1, 1901.

Of the preferred stock, \$8,400,000 is offered for public subscription by Vermilye & Co., of New York, at not less than 105%, and accrued dividends at 7 per cent. from May 1, 1901. The balance, \$7,850,000, has been accepted by the original companies in lieu of cash, as part payment of their properties. The money derived from the sale of this stock will be used in carrying out the contracts for the purchase of the properties and in providing working capital and cash for the extension of the company's works. No public issue of the common stock will be made.

The assets of the new company, without allowing for the advantages accruing from consolidation or for the good will of the various companies, will include a cash capital of \$10,000,000, of which \$2,500,000 will be expended in the erection of an additional plant to double the capacity of the Allis works. The existing plants are valued by Julian Kennedy, of Pittsburg, at \$9,935,000, which does not estimate anything for good will, divided as follows: Edward P. Allis Co., Milwaukee, \$5,120,000; Fraser & Chalmers, Chicago, \$3,205,000; Dickson Mfg. Co., Scranton, \$1,200,000; Gates Iron Works, Chicago, \$410,000.

The net profits for the fiscal year ending May 1, 1902, are estimated by the officials of the respective companies, without any allowance for increase of manufacturing capacity, or for the economies of consolidation, or increase of prices, as sufficient to pay dividends at the rate of 7 per cent. on the \$16,250,000 preferred stock, and about 4 per cent. on \$20,000,000 of common stock. Including the economies from consolidation confidently anticipated by these authorities, the net profits for the same period should exceed the amount required to pay 7 per cent. dividends on both classes of stock. The same officials similarly estimate that upon the completion of the additional Allis works, now in process of construction, the profits will be equivalent to 8 per cent. on the \$16,250,000 of preferred stock, and 10 per cent. on \$20,000,000 of common stock, with a material addition to the surplus account.

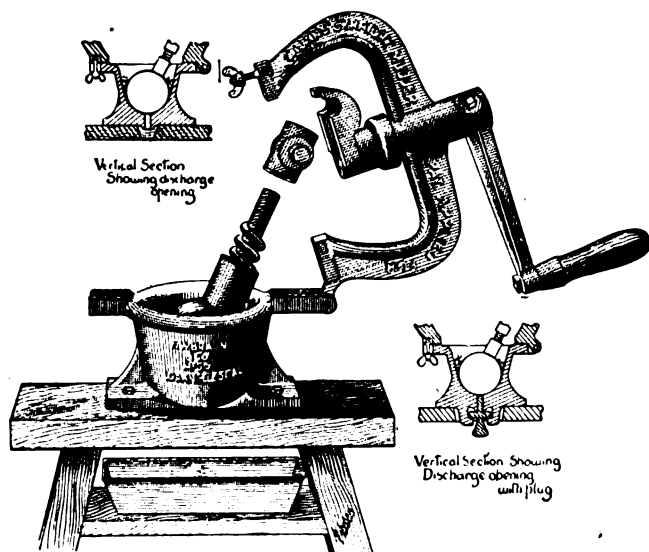


FIG. 2.

against the ball, and at its upper end against the box on the shaft of the ball.

The pestle being a true sphere and the lower portion of the mortar which comes in contact with it being an arc of a true circle, the parts wear to place and never become ineffective by use.

The bale or arch is hinged at one side and secured by a thumb-

NEW INVENTIONS.

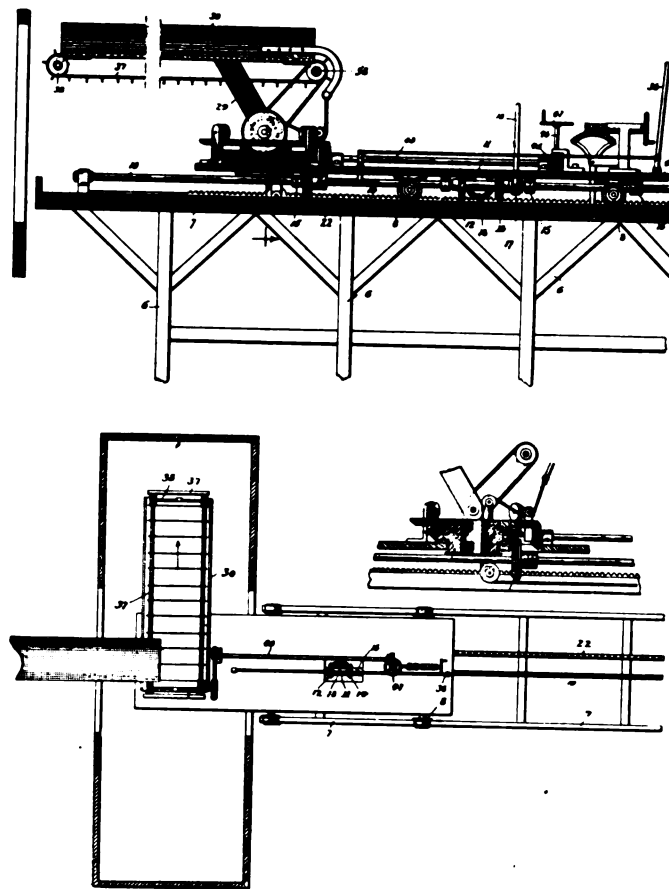
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

Single copies.....	5 cents each.
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COAL-LOADING APPARATUS.

No. 619,191. J. L. LAMB, TRINIDAD, COLO. *Patented March 26, 1901.* This invention relates to an apparatus for loading coal into box cars, the invention embodying a trestleway, on which a carriage is mounted to slide toward and from the car, and a carriage supporting the conveyor mounted to turn and be moved vertically, so that it may be adjusted to properly load the car. Fig. 1 is a side elevation of the invention. The trestlework 6 has two horizontal rails 7, on which run the wheels 8 of the carriage 9, and mounted on a trestle and extending longitudinally with the same is a shaft 10 driven continuously by a suitable source of power (not shown). Splined on the shaft 10 is a sleeve 11, at one end of which is a bevel gear 12, and at the other end of which is a bevel gear 14. The carriage is provided with bearings 15, in which the shaft 10 is held, such bearings moving with the carriage. The sleeve 11 is located between two of the bearings 15, and is adapted

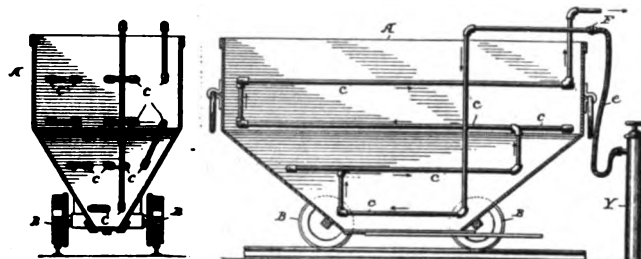


to slide with the carriage and to turn continuously with the shaft 10. A lever 16 is mounted on the carriage and connected by a collar 17 with the sleeve 11, so that upon swinging the lever the sleeve, with its gears 12 and 14, may be moved across either of the gears to engage with the bevel gear 18 mounted on a shaft held in bearings, not shown, but fixed to the carriage. Fixed to the shaft is a spur gear which turns and moves with the carriage, and which engages a rack 22 fixed to the trestlework 6. By these means the revolution of the shaft 10 may, when the gears 12 and 14 are properly adjusted, be caused to revolve the auxiliary shaft and drive the carriage along the trestleway and the rack. Mounted on the outer end of the carriage is a double-faced bevel gear, the under face meshing with the pinion and shaft gear, and the upper face with the gear shown in the figure but not numbered. This double-faced hub has adjustable arms 29 fastened to its upper face, these arms in turn being fastened to the conveyor chute 30. The conveyor frame 30 carries an endless conveyor 37 passing around conveyor rolls 38 held by the frame 30. The inner roll 38 is provided with a sprocket wheel over which passes a chain which connects with the power controlled by the hand lever 36. In using the invention the car-

riage 9 is projected along the trestleway 6 until the outer end of the carriage extends into the car. The double-faced hub is then revolved horizontally so that the conveyor is made parallel to the body of the car. Power is then given to the sprocket wheels, the coal passes along the conveyor chute 30 and falls into the car.

MEANS FOR COOLING ORES FROM ROASTING FURNACES.

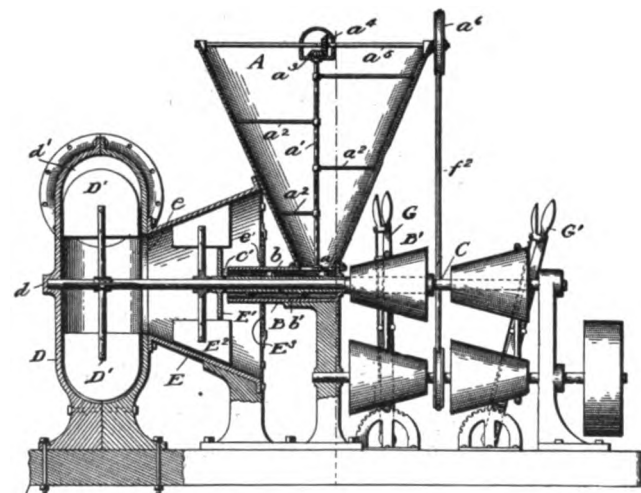
No. 672,373. J. JACOBS, FLORENCE, COLO. *Patented April 16, 1901.* The invention relates to an improved means of cooling ores as they come from ore-roasting furnaces. Fig. 1 is a longitudinal section of a



car, in which are arranged pipes for carrying water as shown. 4 is a car body mounted on wheels 5, and on the car body are arranged the cooling pipes 6, extending side by side at such distances apart that practically all portions of the ore delivered to the car will come within their cooling effect. The cooling fluid is supplied by the hydrant 9, provided with a flexible pipe 7, and having a coupling 8, whereby it may be connected to the inlet end of the cooling pipe 6, so that when the cooling fluid is turned on it will flow through the pipes and the ore in the car which is in contact with the pipes will be cooled.

APPARATUS FOR AERATING AND FEEDING POWDERED COAL.

No. 671,161. A. A. DAY, BROOKLYN, N. Y. *Patented April 2, 1901.* The invention, a sectional view of which is shown, consists of a positively operated and controlled feeding mechanism and aerator for mixing the powdered coal thoroughly and intimately with air and an ejecting mechanism for forcing the air and coal into the furnace, where it is consumed with perfect combustion of the fuel, thereby obviating entirely the formation of smoke. A represents a hopper designed to receive powdered coal and provided at its bottom with a discharge aperture a, which communicates with a cylindrical trough B. In order to prevent the mass of coal in the hopper from packing, a vertical shaft a', mounted at its upper and lower ends in bearings, is carried by horizontal bars extending across the top of the aperture and across the discharge aperture a. The shaft a' is provided with a bevel pinion a², which meshes with a similar bevel pinion a³, that is attached to a rotating shaft a⁴. The whole shaft receives motion from a pulley wheel a⁵, and the belt f². C represents a shaft which extends laterally through the trough B, and has one end supported in a bearing at c' and the other end supported in a bearing d, formed in the casing of the ejector D. Within the trough B is located a worm b, secured to a sleeve b' which is loosely mounted upon the shaft C so as to turn independently. The projecting part of the sleeve b' is provided with a conical driving pulley b, by means of which the speed of the worm

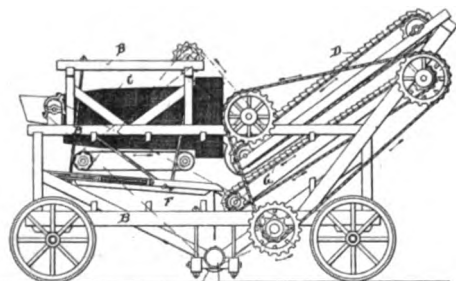


may be varied. The opposite end of the trough B is open and extends within a chamber E, called an aerating chamber. E represents a spreading device, located within the aerating chamber adjacent to the discharge end of the trough B and consisting of a circular plate secured to the shaft C. Within the aerating chamber E are a series of blades E² which are secured to the shaft C and rotate with it. The aerating chamber E is provided on the side opposite the trough B with an outlet c.

This connects with the ejector *D'*. The inner periphery of the ejector chamber *D* is provided with a discharge aperture *d'*, preferably located near the top of the casing. Within the casing *d* are a series of radially disposed ejecting plates. The coal which has previously been pulverized to a floury condition is supplied to the hopper *A* and from the hopper it passes to the trough *B*, while it is fed by means of the worm *b* into the aerating chamber. As the coal leaves the trough *B* it is thrown toward the inner periphery of the aerating chamber by the centrifugal action of the blades *E'*, the spreader *E* preventing it from passing centrally through the aerating chamber. The action of the blades *E'* thoroughly mixes the fine powder with air, which is admitted in regular quantities through the aperture *d'*. As the air comes into the state of saturation it passes out into the ejector casing *D*, where it is taken up by the ejector blades and discharged through the outlet *d'*, which is connected by means of a pipe or tube (not shown) to the furnace, where a mixture of air and powder is consumed, producing a white-hot flame without smoke. It is to be understood that no pulverizing action takes place in any part of the apparatus, as the coal is so finely powdered before being delivered to the hopper that further subdivision of it is not desirable.

CONCENTRATOR.

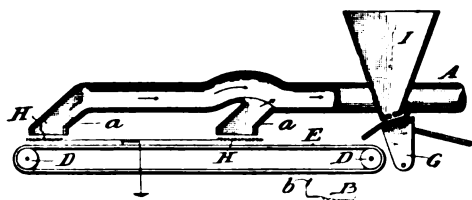
No. 671,116. E. G. NEIGHBOR, OGDEN, UTAH. *Patented April 2, 1901.* The concentrator is for the purpose of separating gold from earth and gravel in placer mining. In placer mining many of the deposits carry more or less fine gold, which, in the ordinary processes of mining, floats off, especially where a large amount of water is used. Also, much of this fine gold is lost where water and tailings flow in the same direction. This apparatus is designed to carry away the tailings against an inflow-



ing current of water, and flour gold is said to be washed out of the tailings and saved. The various mechanical features of the invention are shown in the figure which is a side elevation. *B* represents the framework of a water-tight tank within which a revolving screen *C* is turned. This screen is a double-compartment wire screen and is revolved by power in such a manner that the lower portion of the screen dips into the water tank so that the screen is partially immersed in water and the ore therein subjected to a washing which removes the sand and dirt and carries the fine material through the meshes of the screen. The coarse portion of the ore passes out of the central screen onto the bucket elevator *D*, by which it is removed. The fine portion of the ore which passes through the lower or outer screen, falls upon a shaking table *F*. The ore or gold passes through this table, which is perforated, and falls to the bottom of the tank. Fine gravel is raised by the elevator *G* out of the tank. As the barren material rises towards the surface of the water in the tank it meets a current of water coming from the opposite direction, which, it is claimed, causes the float gold to remain within the tank.

PROCESS OF CONCENTRATION.

No. 670,441. H. M. SUTTON AND W. L. STEELE, DALLAS, TEX. *Patented March 26, 1901.* The invention relates to a process of separating a conductive substance from a non-conductive substance, and more particularly to separation by means of electrifying the conductive particles and repelling said particles, while the non-conductive substances are not so repelled. Heretofore in electrical ore separation static electricity has been used for concentrating ores by electrifying the particles, but difficulty has been experienced in controlling the electrified particles, and they not only mutually repel each other but are alternately attracted and repelled from any solid substance used to effect the separation of the conducting from the non-conducting particles, and the result is a general scattering of the metallic or other conductive particles without an effective separation. An apparatus for carry-



ing out the process is shown in the accompanying figure, which is a longitudinal section through one form of the concentrator. In the figure, *A* designates an exhaust or suction pipe of any desired construction, provided at points with hoods *a*, and connected at its discharge end with a suitable device for creating a suction or exhaust therein, preferably a blower. Beneath the hoods *a*, an endless belt *E* is suitably mounted upon rollers *D*, and is electrically charged by means of a conductor *B* from a generator and any suitable connections, for

instance, as a brush *b*. Interposed between this belt and the suction hoods *a* is a metallic screen *H*, constituting an electric conductor, and connected with the earth by means of a ground wire so as to return to the earth any current received by the screen through the metallic particles coming in contact therewith. The traveling belt *E* is supplied with a thin layer of ore by means of the hopper *I* and shaker *G*. As the belt moves, as shown by the arrow, the gangue is raised up through the hoods *a* and the metallic particles are carried and fall off the belt into a trough.

PATENTS ISSUED DURING APRIL AND NOT ILLUSTRATED.

- No. 671,069. Quicksilver receiver, F. Kaeferle, Hanover, Germany.
- No. 671,071. Ore-roasting furnace, R. F. Pearce, Butte, Mont.
- No. 671,081. Apparatus for making gelatin dynamite, E. E. Green, Santa Clara, Cal.
- No. 671,177. Derrick engine, J. V. Beekman, Plainfield, N. J.
- No. 671,209. Compressed-air pump, R. W. Elliot, Oakley, Cal.
- No. 671,244. Air-pump governor, S. B. Stewart, Jr., Schenectady, N. Y.
- No. 671,268. Discharging device for endless conveyers, J. M. Dodge, Philadelphia, Pa.
- No. 671,276. Ore concentrator, A. Fritsch, St. Louis, Mo.
- No. 671,286. Car loader, S. E. Kurtz, Sac City, Iowa.
- No. 671,315. Conveyer, T. A. Edison, Llewellyn Park, N. J.
- No. 671,348. Ore Concentrator, J. H. Michelson, Butte, Mont.
- No. 671,389. Method of treating ores, M. Seligsohn, Denver, Colo.
- No. 672,298. Trough concentrator, C. A. Taylor, Leadville, Colo.
- No. 672,302. Combined kiln and drying oven, H. F. J. Weijers, Udenhout, Netherlands.
- No. 672,309. Process of locating metallic minerals, F. H. Brown, Los Angeles, Cal.
- No. 672,358. Endless-belt conveyer, J. M. Dodge, Philadelphia, Pa.
- No. 672,413. Gold-saving appliance, T. J. Burke, Los Angeles, Cal.
- No. 672,421. Loading mechanism for conveyers, A. L. Le Grand, West Pittston, Pa.
- No. 672,524. Amalgamator, G. Ghiglieri and J. M. Schofield, Stockton, Cal.
- No. 672,616. Method of breaking rock, T. A. Edison, Llewellyn Park, N. J.
- No. 672,617. Apparatus for breaking rock, T. A. Edison, Llewellyn Park, N. J.
- No. 672,637. Process of treating zinc-bearing ores for obtaining zinc, etc., S. O. Cowper-Coles, London, Eng.
- No. 672,650. Miner's squib, E. Reese, Plymouth, Pa.
- Nos. 672,739 and 672,740. Amalgamator, L. Mayhew, New Whatcom, Wash.
- No. 672,773. Manufacture of billets, W. B. Hughes, Philadelphia, Pa.
- No. 672,814. Drill-casing extractor, G. S. Wilson and S. E. Loy, Aurora, Mo.
- No. 672,858. Caisson, W. H. McFadden, Pittsburg, Pa.
- No. 671,558. Assay furnace, D. Laird, Forfar, Scotland.
- No. 671,573. Ore separator, F. H. A. Wielgolaski, Christiania, Norway.
- No. 671,591. Conveyer for ropeways, M. E. Hallidie, San Francisco, Cal.
- No. 671,818. Mining machine, C. E. Davis, Chicago, Ill.
- No. 671,925. Excavating machine, D. H. Snyder, Toledo, O.
- No. 671,704. Process of treating ores containing silver or silver and gold, E. D. Kendall, Brooklyn, N. Y.
- No. 671,970. Rock drill, H. Koch, Tarrytown, N. Y.
- No. 671,973. Machine for saving fine and flour gold, W. Moberry, Oceano, Cal.
- No. 671,988. Method of treatment of amalgam containing copper or precious metals, J. H. Burfeind, Salt Lake City, Utah.
- No. 672,039. Excavator, G. W. King, Marion, O.
- No. 672,054. Electric crucible furnace, G. de Chalmot, Holcomb's Rock, Va.
- No. 672,065. Apparatus for oxidizing ore, H. C. Lawrence, Denver, Colo.
- No. 672,072. Mining dredge, W. T. Urie, Kansas City, Mo.
- Nos. 672,082 and 672,083. Rock drill, L. T. Sicka, Denver, Colo.
- No. 672,097. Well boring apparatus, F. A. Eastman, Litchfield, Minn.
- No. 672,154. Tool for removing broken sucker rods from wells, C. O. Taylor, Petrolia, N. Y.
- No. 672,223. Crushing machine, H. H. Boggs, Syracuse, N. Y.
- No. 672,991. Explosive, S. D. Smolianinoff, Washington, D. C.
- No. 673,058. Drive mechanism for ore concentrators, M. S. Leve, Fruitvale, Cal.
- No. 673,060. Hoisting bucket, T. J. Pratt, Paterson, N. J.
- No. 673,104. Rock drill, Warren Wood, Paterson, N. J.
- No. 673,151. Cable conveyer, D. Aramburu, Mexico, Mex.
- No. 673,172. Magnetic separator, R. McKnight, New York, N. Y.
- No. 673,174. Furnace for roasting ores, A. P. O'Brien, Richmond, Va.
- No. 673,195. Apparatus for pulverizing ores, J. K. Clark, Butte, Mont.
- No. 673,205. Coal drill, M. Hardsocg, Ottumwa, Iowa.
- No. 673,212. Combined shield, shaker, and conveyer for crucibles, W. S. Mather, Newark, N. J.
- No. 673,231. Continuous-burning kiln for bricks or other articles, A. Adams, Old Flotton, Eng.
- No. 673,320. Bucket elevator, C. W. Levalley, Milwaukee, Wis.
- No. 673,347. Method of manufacturing explosives, H. W. Wiley, Wash.
- No. 673,360. Car-unloading apparatus, W. O. Dequede, New Orleans, La.

Mines *and* Minerals

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MINING ON THE KLONDIKE.

Method of "Firing," Also of Thawing by Steam, and Description of the Mining Methods Used.

Written for MINES AND MINERALS, by A. J. Bowie, Consulting Engineer, San Francisco, Cal.

Discovery.—Information received from an Indian in the spring of 1896 led one, George Carmack, a pioneer in the Northwest Territory, to prospect a tributary of the Troandye River for gold. His labors were rewarded by its discovery on a stream subsequently named Bonanza Creek, about thirteen miles distant in a southerly direction from what is now known as Dawson, estimated elevation 1,012 feet above sea level, distance from St. Michael's on Behring Sea, via Yukon River is about 1,800 miles, Yukon Territory.

The Troandye (Indian name) River, now corrupted to Klondike, enters the Yukon River fifteen miles above Fort Reliance. It is a swift, shallow and clear stream, flowing over a bed of coarse gravel about 175 yards wide at its mouth. Its length is still unknown, though prospectors have ascended it fully one hundred miles, the last twenty miles flowing between low-wooded mountains which descend to the very edge of the stream. The district drained by it above the point where Hunker Creek joins (12 miles above Dawson) is a "terra incognita" to the miner. The valley beyond broadens into a plain, and further on the mountains converge to the stream.

The gold-bearing tributaries of the Klondike rise toward the east and debouche on its southerly side in the following order:

1. Bonanza Creek (about 23 miles long) joins the river one and a half miles above the junction of the Klondike and the Yukon. 2. Quigley Creek (5 or 6 miles long) debouches about three and a half miles above the mouth of Bonanza. 3. Three

miles farther up stream, Bear Creek, 12 miles long, empties, and 4. Four miles beyond Bear Creek is Hunker Creek, about twenty miles in length. 5. Slate Creek (approximately 12 miles long) meets the Klondike fourteen miles above the mouth of Hunker.

Fourteen or fifteen miles beyond Slate Creek is the confluence of "Too Much Gold Creek" and the river, and between "Too Much Gold" and "All Gold Creek," which is ten miles beyond "Too Much Gold" and the Klondike, the river forks. The first mentioned creek is estimated to be about twenty-three miles in length and the latter to exceed twenty miles. The grades of all

the creeks are very light. The widths of the creek bottoms, from rim to rim, vary in the several tributaries. Bonanza Creek has been estimated to be from 300 to 1,200 feet—averaging less than 700 feet, and El Dorado Creek, a tributary of Bonanza Creek, eight miles long, is between hills from 200 to 800 feet apart at their base.

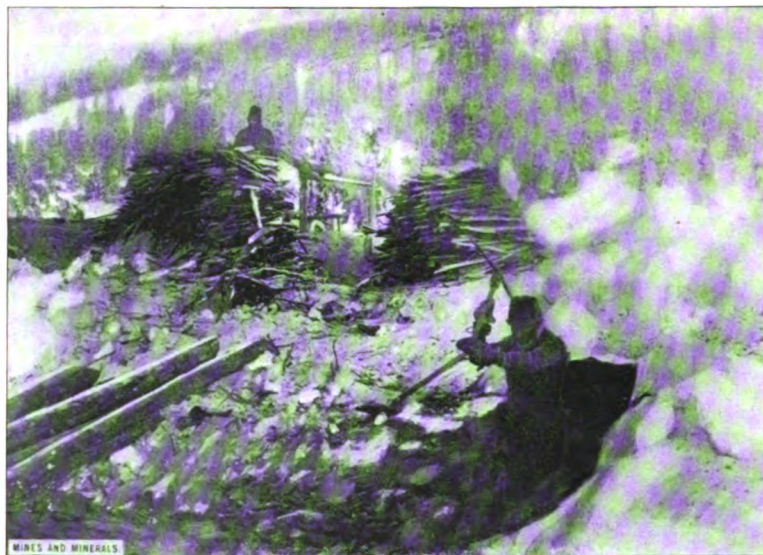
El Dorado Creek, the scene of the subsequent gold discoveries, joins Bonanza Creek at Grand Forks, about one-half mile above Carmack's Bonanza discovery.

Indian River Division.—Dominion Creek, Sulphur Creek, Quartz Creek, and other tributaries of Indian River, all within forty-five miles of the mouth of the Klondike, though situated in the Indian River division of the Yukon District, are

considered a part of the Klondike Gold Fields. (Vid. Appeal of Yukon miners to the Dominion of Canada. Pub. Ottawa, Canada, 1898, which gives a most interesting account of the condition of mining affairs in the Provisional District of Yukon.)

The published accounts of the richness of El Dorado and Bonanza Creek placers caused the "rush" from all parts of the world to this country during 1897 and 1898.

Mineral Resources.—The mineral resources of this "Land of Northern Lights and Midnight Sun," with the exception of a small area around Dawson (outside of a radius of 50 miles the country is unknown) are still undeveloped, owing to the severity of winters and the difficulties of summer traveling.



STARTING A SHAFT IN THE KLONDIKE.

Seasons.—June, July, August, and September are called the Summer months and all the others are included in winter. In mid-winter day is only four hours long, and in mid-summer there are twenty-four hours daylight. The temperature ranges from 95 degrees Fahrenheit in the shade in the latter season to 70 degrees below zero in the winter, a lower temperature than recorded by Nansen in Greenland, or in his more recent Polar explorations.

Road-Trails.—No roads existed in the Yukon Territory, not even in Dawson. Mere zigzag lines through "muck" and water indicated the summer trails. The surface of the ground is covered with moss under which, where undisturbed, the soil is frozen to bed rock at all seasons. The water from melting snows, rains and springs, partially absorbed by the moss, drains through the creeks into rivers which flow to the sea.

Muck.—The soil underlying the moss, locally called "muck" is composed of the lighter silts, clay and sand, constituting a thick bed overlying the auriferous gravels. Surplus waters collect under the moss forming immense pools and quagmires. These bogs or swamps, through which "the traveler flounders painfully" are scattered over plateaux and along the flanks and on the ridges of the highest ranges.

Travel.—The prospector carrying on his back his tools, food and blankets, travels slowly and the work is so laborious "that only strong men dare attempt it and few succeed in getting far from Dawson." No supply station existed nearer than Dawson, and on a thirty-mile tramp, a man could pack but a very limited food supply, consequently work has been necessarily restricted.

Winter Temperatures.—In winter, travel over these vast solitudes of snow-covered stretches is not inviting. Bleak winds, drifting and blinding snows, temperatures ranging day after day 40, 50 to 70 degrees Fahrenheit below zero, and no shelter beyond the creeks, were conditions to be met which appalled the stoutest hearts, while the remains of many a brave fellow fallen on the trail evidenced the hardships of the country and the severity of the Arctic climate.

Underlying Rocks.—Granite, granitic schists, and metamorphic slates underlie the auriferous wash of the Klondike. The Klondike placers so far as developed have presented no novel geological features.

Origin of the Placers.—Their origin, judging from their composition and positions may be ascribed to erosions occurring at different geological periods in which submergence and elevation were the most important factors. The silts which cover the gravel wash indicate lacustrine origin, and according to the Canadian (Vid. Geological Survey of Canada An. Report 1887, pp. 42, 43, 46,) geological investigations those of the Upper Yukon appear to have been largely derived from material ground out of the rocks by glacial action. The Klondike fields can be compared to those described by Murchison as occurring on the flanks of the Ural. There are no gold bearing river channels like those existing in California, nor is there any evidence of gold placers of glacial origin.

Occurrence.—These placers are found along the lines of natural drainage, the topographical features indicating the general direction of the gold alluvions. This does not imply that the miner sinking on a stream flowing in its present course will strike, on first attempt, the channel, but refers to the general course of the wash as indicated by the enclosing ranges.

Depth of Gravel.—The depth of the gravel varies with the waves in the bed rock and its position in the line of wash, ranging in places from only a few inches up to eight and ten feet. This must not be confounded with the "pay streak" which varies in the gravel from a few inches to four feet in thickness and in some instances more, but they are exceptions.

Pay on Bed Rock.—On Dominion Creek, 35 miles distant southeasterly from Dawson in the Indian River District, so far as ascertained, the pay is confined chiefly to the bed rock, and it is in such localities that fabulously rich pans are obtained which are misleading.

Location of Pay.—The location of pay gravel can only be determined by explorations, and, when struck, it requires development to predetermine economical results. These subterranean creeks or gulch channels will be found to follow along between the encompassing

ranges in conformity with the bed rock and the shifting of the flow, not in any way indicated by the present surface conditions. (The old channel deposits, where developed, are found to have followed a direct course with large curves, but no sinuosities). Corroborative of this can be cited an instance where on a Bonanza Creek claim ten shafts were sunk without striking pay, the eleventh shaft finding it. This is not an exceptional case.

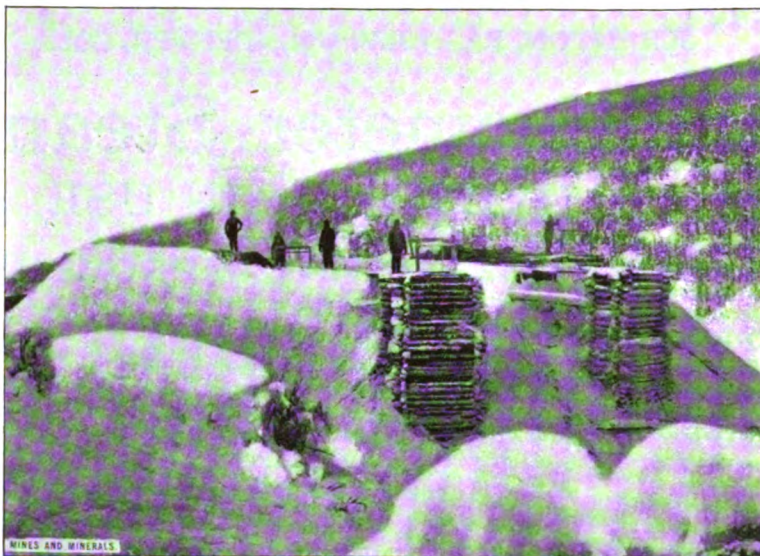
Pay Dirt.—The term "pay dirt" is meant to include so much of the gravel and bed rock as can be profitably mined. Pay dirt with this definition is a variable quantity, dependent not only on its gold contents, but on the depth of the gravel and on the cost of labor and supplies. These identical conditions fix the workable width of the wash, even within the restricted lines of the rim rock.

Hill Deposits.—Prospectors in the summer of 1898 discovered by means of shafts, sunk along the hills bordering Bonanza and El Dorado Creeks, an upper line of auriferous alluvions several hundred feet above the creek bottoms. The course of this deposit skirts the top of French Hill, running down El Dorado to Gold Hill, thence to Cheechaco Hill, along Bonanza Creek across Adams Gulch following

Bonanza Creek considerably further down, finally crossing it and debouching near the Klondike. This upper deposit consists of masses of quartz carrying gold. This quartz mass bears every evidence of its reef or vein origin, and as far as developed is from 200 to 300 feet in width.

Value of Hill and Creek Gold.—The gold it contains is worth from \$10.50 to \$12 per oz., whereas the creek gold, which is well water worn, varies from \$15 to \$17 per ounce.

Breaks Causing Local Enrichment.—Wherever a break in the hillside line occurs, the claims on the creek immediately below



DUMPS CONTAINING \$450,000, SHOWING SHAFT CRIBBING.



FIRE JUST STARTING IN SHAFT, KLONDIKE REGION.

are invariably rich. This has been proven notably at No. 17 El Dorado, and on the "Dick Lowe Faction," and on No. 2 below Discovery on Bonanza Creek, where the working of these claims showed the local enrichment of the placers, not only by the increased bullion yield, but by the presence also of the two distinct classes of gold obtained in the "clean-ups."

These local enrichments are in marked distinction to deposits found on the line of the junction of two flowing streams, which are here proven to follow the same course as experienced in Australia, the rich ground being below the junction on gently undulating bed rock.

The Lower Klondike.—The lower Klondike region is very rugged and has been described as "hill crowding hill, mountain jostling mountain, on and on they sweep to the uttermost reach of the vision." (P. 31, Appeal of Yukon miners to the Canadian Government.) The remote situation of the mines, the difficulties of travel with attendant privations, high prices of labor and supplies, apart from questions of legislation, have here made mining unique.

The Season 1897-1898.—The season of 1897-8 found the miner in this bleak district with a general scarcity of provisions staring him in the face, with few tools and appliances for mining at his command. That gold existed in many of the creeks had been definitely ascertained, but how to extract it and mine at a profit taxed his ingenuity. There was no powder at hand, no machinery or steam power obtainable; subsequently some powder was obtained and blasting tried on the frozen ground. Apart from its prohibitive cost, the results were unsatisfactory. Recourse was taken to firing.

Free Miners' License.—The creek bottoms and hillsides were fairly well wooded with birch and stunted spruce, and by virtue of the Free Miners' License, any miner had the right to cut all the wood he required for the use of his claim, on any government land not previously covered by a concession. The cost of fuel at this period was that of cutting and hauling. The rapidity with which the available timber was removed and used from the surrounding country seemed incredible. Every one resorted to firing; the whole country teemed with burning shafts, discharging smoke in volumes, darkening what little was left of daylight.

(For the photographs accompanying this paper I am indebted to Mr. A. A. Martin, of San Francisco, Cal.—A. J. B.)

Channel Mining.—The channels are exploited and mined by means of shafts sunk 30 feet apart when in pay gravel. Drifts opening faces for breasts are driven half way from each shaft forming air connections, the distance of a "box length" (12 feet) being considered the most convenient for skidding. All the gravel within that distance being worked through the respective shafts.

Shafts.—Location.—As a rule shafts are located as near the line of present surface drainage as circumstances and conditions permit. Their depths vary in accordance with their location and the position of the deposits on the creeks. On Dominion Creek they may be averaged at 20 feet, on Bonanza, El Dorado, and Hunker creeks from 12 to 25 feet, while on Sulphur Creek 40 to 50 feet will be the average required to work the pay streak.

Timbering.—Timbering is rarely required on account of the compact overlying muck, which, after the gravel has been mined, settles down at the point of least resistance, until it rests on bed rock. The surface dirt around the collar of the shaft is generally secured by cribbing with round poles, and as the dumps are raised, the mouth of the shaft is built up with notched timbers closely set together. What is most noticeable is the number of shafts required by this system of mining, entailing an enormous expenditure for dead work.

The field presented to the miner is not especially an inviting one for work. The surface in winter is covered with snow or ice, under which lies the moss one or two feet deep, reposing on the soil and muck already described, which in turn overlies the gravel. The location of the shafts having been determined on, mining commences.

As preliminary to shaft-firing, the moss is first removed from the ground with a mattock, then the muck, which varies in places from six to forty feet in depth, is attacked with a pick. In a shaft 4 × 6 feet sinking progresses at the rate of about 5 feet per ten-hour shift.

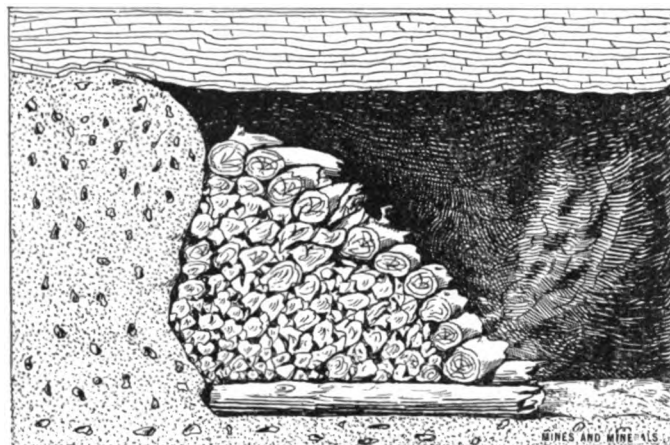
Gravel.—When the gravel is encountered firing is begun, 8 to 15 inches being thawed per burning, depending on the character of the gravel, moderate sized cobbles carrying the heat deeper than fine sandy material.

Fires.—The fire made with dry kindling and logs covering the bottom of the shaft is lighted and allowed to burn out, when the shaft is cleaned of the thawed gravel, and the burning continued until bed rock is reached. It can be frequently arranged so as to have two fires on a ten-hour shift. The bed rock being reached, drifting fires are started around the sides of the shaft.

Drift Firing.—Firing for drifting and breasting is totally different from firing for sinking. Dry kindling wood is prepared

and cut in convenient lengths for splitting, say 2½ feet long. This kindling is laid along the face of the ground to be thawed on cross-pieces, spaced 2½ feet apart. Over the kindling dry wood and odds and ends of brands left from former fires are piled, which are in turn closely covered with green wood piled lengthwise, the whole forming an angle from the ground to the top of the pile against the face of the gravel to a height of 2½ feet carefully banked.

The space between the cross-pieces under the kindling is left for purpose of draft and lighting. A fire built as here



SKETCH OF WOOD PILED FOR DRIFT FIRING.

described against a breast 25 feet long and 2½ feet high requiring ½ cord of wood, will thaw about 5 cubic yards of gravel as it lies in the deposit. Wood for firing formerly cost \$25 per cord.

Time of Burning.—When the weather is very cold and the draft strong, the fires are not lighted before 10 P. M., and should burn out between 5 A. M. and 6 A. M. the following day, in time for the works to be cleared of smoke and gas to permit the morning shift to resume operations.

Firing on Dominion Creek.—During the winter of 1898-9 on Dominion Creek at No. 13 above Lower Discovery claim, it was found that firing four faces, each 30 feet in length, required the labor of one man two hours daily to cut sufficient shavings with a draw-knife to make the fires, or a daily cost of \$2 for shavings. Messrs. Waterman and Mayon, who were working the claim, substituted rags soaked with kerosene. The results obtained were most satisfactory. Ten gallons of kerosene costing \$28 last six weeks, as against \$84 for shavings. Apart from the saving of time and money the burning of the fires was assured, a most important feature.

This system of mining only allows seven hours' work for the handling of the gravel, the remaining time being required for sawing, splitting the wood, and laying the fires.

Action of Heat on Ground.—When the fires have started and the ground becomes heated the gravel soon drops from above and buries the green wood covering, retaining the heat, which with the smoke creeps along the roof of the drift or breast, making for the shaft. There results a caving of the material along its entire course, particularly around the shaft, the caves extending to the muck, necessitating the handling of tons of waste, and later, with the advent of mild weather, the destruction of the pit.

Handling of Gravel.—The gravel as thawed in the breast, is handled immediately to prevent its freezing back. It is shoveled into wooden buckets holding about 120 pounds each, skidded or dragged to the shaft and windlassed to the surface, where it is dumped alongside of the shaft and freezes over again. There it remains to be thawed out by nature or otherwise till sluiced in summer.

Work Shut Down.—Breasting and drifting cease with mild weather on account of the water in the drifts, caving of the ground, and dangers from asphyxiation. The gravel being mined and piled in dumps around the shafts, with the advent of the water season, sluicing commences, the necessary preparations for same being made already.

Impounding Waters.—The light grades in the creeks necessitate the impounding of waters to enable the miner to sluice the dirt, and also occasion frequent handling of the tailings. As the claims vary from 250 to 500 feet in length, it is patent how aggravated the situation becomes.

Dams.—It is estimated that an ordinary temporary dam costs per claim \$1,000, and structures are known to have required as much as \$8,000 to erect. Most all of the dams, such as they are, are sooner or later in the season swept away by flood.

Centrifugal Pumps.—Centrifugal pumps in instances are found to be convenient and economical for supplying water for sluicing and have been found very efficient for draining underground works. In many instances old works have been used as storage reservoirs, and the water subsequently pumped from them and used for sluicing purposes over and over again.

Canvas Hose.—Canvas hose is an excellent substitute for flumes, where the price of labor and material is so high, and as the quantity of water run per sluice-head, here called 60 miners' inches (Canadian measurement), is so small, it can be used to great advantage if one be permitted to take the water out sufficiently high on the creek, above the claim upon which it is to be employed.

Waste Ditches.—The cost of the waste ditches to carry off surplus waters of the creeks depends on their length, which vary with attendant circumstances.

Sluices.—Sluices, so-called, are built of 1-inch pine lumber, 12 ft. lengths. They are 11 inches at top, 10 inches deep, bottoms 13 inches wide, 10 inches deep. These boxes are nailed together and made in 12 ft. lengths, and strengthened with strips for small posts, and sills are required. The boxes are set one in the other by dropping the narrow end of the box into the flared upper end; the edges and leaks being stopped with rags. This style of sluice, as set, is well calculated to afford the smallest discharge for the material used in its construction, as well as to entail a continuous loss of grade.

Riffles.—Pole riffles are in general use. The boxes are cleaned up daily after sluicing. No quicksilver is used, the bulk of the gold being caught in the boxes into which the dirt is shoveled. The gold obtained is taken in pans or kettles, panned out, dried and cleaned of sand and iron and ready for the market.

Sluice Grade.—The grade of the sluices is apparently regulated by the idea of the person running the claim. The sluices are placed as close as they can be conveniently to the dumps. When the water season arrives and the gravel is sufficiently thawed, it is shoveled by hand into them. The men along the sluice throw out all the rocks which the water will not carry off. Large rocks are taken by hand and cleaned in the sluices. The attendant expenses of this method of sluicing are considerable.

Economical Question.—The workings of these placers as described brings one face to face with the study of the economical question involved in order to establish a basis for their valuation. It is a well authenticated fact that ground in several of the claims in the Klondike Gold Fields have yielded \$35 per cubic yard, but neither the extent of these areas nor the cost of working them has ever been stated. Auriferous deposits with a high yield per cubic yard and a large available area do not alone constitute a rich mine, as the commercial value of a mine is determined by the relation of the yield per cubic yard to the cost of obtaining its corresponding yield in precious metal, or, in a word, the difference between the money yield of the bullion and its cost of production.

Official Data.—Official data on file in the offices of the Canadian Government give "the cost of handling dirt (summer work) from ground sluicing to clean-up averaged (labor bills) \$5 per cubic yard on the entire quantity moved," and "the cost of handling dirt from shaft sinking to clean-up (winter work) averaged \$12 per cubic yard." These are results of workings done on El Dorado Creek and Bonanza Creek in 1897-8, ordinary labor being \$1.50 per hour and provisions correspondingly high.

In 1898-9 ordinary labor on Dominion Creek ranged from 80 cents to \$1 per hour, the expenses of living being the same as that of previous years. The annexed tabulated statement prepared by Douglas Waterman, Esq., shows in detail the exact cost of the working by the firing system on claim No. 13 above Lower Discovery, on Dominion Creek, after the ground had been thoroughly opened and all attendant preliminary work completed.

The months of February, March, and April were the most advantageous seasons for breasting. Labor was paid \$1 per hour. No charge is made for wood beyond cost of cutting and hauling. Distance hauled, one-half mile down hill.

1899.	Feb.	March.	April.
Number of shafts from which dirt was hoisted...	4	5	4
Number of buckets hoisted	10,872	13,186	11,910
Cubic yards	400	490	440
Number of men employed	12	12	8
Number cords wood burned	25	25	15
Labor expense	\$1,991.25	\$2,445.75	\$1,625.50
Wood expense	375.00	375.00	225.00
Total expense	2,366.25	2,820.75	1,850.50
Cost per cubic yard	5.91	5.75	4.20

Thawing by Steam.—In the fall of 1898 a small boiler was erected on Claim No. 2, El Dorado Creek, to experiment on thaw-

ing ground with steam, the idea having suggested itself that by a direct application of dry steam more economical results could be obtained than by firing.

The crude test showed that sinking could be rapidly and cheaply done, but it was not considered to be applicable to drifting. Several other trials of steam thawing were made on Sulphur Creek in the winter of 1898-9. Although the apparatus used was most inefficient the results were so encouraging that the idea was quickly grasped, and the opening of navigation in 1899 found nearly every scow and steamboat arriving at Dawson carrying in their cargoes boilers of all sizes from 5, 10, 20, 25 to 40 horsepower. The West Coast had been scoured for small hoists and boilers, the pipe boiler, on account of its light weight, being the type generally selected. Small hoisting engines and pipe fittings made their appearance, and with the opening of winter work steam whistles echoed all along the creek.

The advantages of steam thawing seemed soon to be recognized by all claim owners, who, though they were not familiar with its workings, were afraid some other person might work more economically, so rushed into the market and purchased the plants even before they arrived.

First Experience With Thawers.—The experiences with these "steam thawers" demonstrated in nearly every instance that the capacities of the boilers were insufficient to meet the requirements of the "points" they were using. In general the steam plants were poorly mounted and unprotected against the elements. The boilers and steam pipes were uncovered, and the steam from the boilers to the breasts underground (sometimes 200 feet distant) passed through bare iron pipes.

With the temperature of these creeks far below zero Fahrenheit, it can be readily understood how great must have been the waste of fuel and losses due to condensation. Injectors feeding the small boilers did not keep up the water supply and permit the generation of sufficient steam to feed the "points," resulting in loss of time and frequent deluging of the pipes.

Steam Thawing in 1899-1900.—During the winter of 1899-1900, steam thawing, as the plants were perfected, gradually showed what could be achieved and the great advantages over the old system of firing, to wit:

1. It can be used at all seasons.
2. Absolute security to life.
3. No loss of time, can be prosecuted continuously.
4. Dead work reduced to a minimum.
5. Saving in handling waste.
6. Absolute control of the heat.
7. Economy in fuel—direct application of the heat.
8. Expeditious and economical extraction of the gravel.

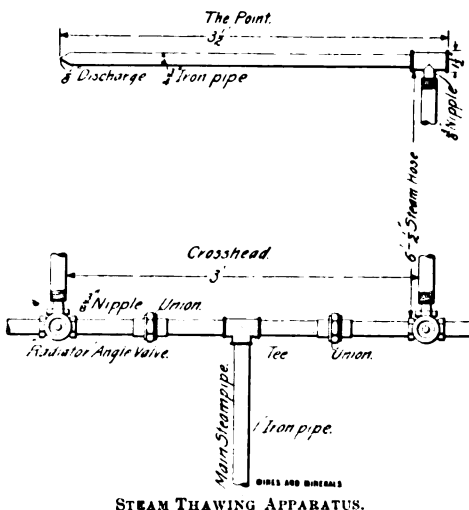
Gravel better thawed and with the use of a small hoist, there is additional economy of labor with an increased output.

Thawing Plants.—A thawing plant should consist of a boiler, pipes, set of points, and a hoisting engine with drums complete. The requirements determine the horsepower of the boiler, each point used requiring at least two horsepower. The additional power necessary for the hoist depends upon the amount of work to be performed. A 10-point plant should have a 30-horsepower boiler. The boiler should supply dry steam.

The pipe boilers, which have been extensively used, are short lived, large consumers of fuel, and undesirable. Locomotive boilers have given the best results, but any good boiler will do the work; it is only a question of cost, \$100 per horsepower being the prevailing rate at Dawson.

Steam Outfit.—The boiler should be fitted complete with steam drum, mud drum, gauges, valves, feed-pump, oilers, wrenches, complete set of tools, including taps and dies, and sufficient asbestos or magnesia covering to thoroughly protect the plant and steam pipes to be used underground. Special attention should be given to the thorough protection of the main steam pipe leading from the boiler to the shaft.

Feed Pipe.—The size of the main feed pipe is regulated by



the number of points; with 10 points a one-inch diameter pipe is necessary.

In the drifts the steam pipe is fitted with unions at convenient distances for disconnecting and drainage purposes. The feed pipe is carried down the shaft, and along the drift to the breast where a T is put in, and a cross-head run the full length of the face to be thawed.

Cross-Head.—The cross-head is fitted with valves 3 feet apart, each point having its own valve. A 6-foot length of $\frac{1}{2}$ -inch steam hose connects the point with the valve.

Points.—The points are made of $\frac{1}{2}$ -inch diameter iron pipe, $3\frac{1}{2}$ feet long, drawn to a point at one end, with a $\frac{1}{2}$ -inch diameter discharge, having on the other end a heavy steel head $1\frac{1}{2}$ inch diameter, 4 inches long, welded or screwed on, and into its side is placed a $\frac{1}{2}$ -inch nipple connecting with the hose.

As the points must be drained each morning, a "radiator" valve with a union attached is found most convenient. The hose is fastened to the nipple with baling wire, having first heated the nipple and inserted it hot in the hose. Experience has proven that clamps are of no value. When the pipes have all been connected, steam is turned on.

Starting Points.—In starting the points they are held against the face one by one, and worked into it as the ground thaws, for about $1\frac{1}{2}$ feet, being driven with a wooden maul the remainder of their length.

The starting of the point (that is to make the point hold its own weight) only requires about five minutes, the point-man inserting them one after another, but it will take fully three hours to work ten points in their full lengths. When the points are in, a full head of steam is turned on, and they are allowed to remain in the breast until 5:30 A. M., the following day, supposing that the point-man commenced his shift the previous evening at 8 o'clock. When the points are withdrawn, the pipes are disconnected and the water pumped from the sump.

Ground Thawed.—An examination of the ground will show that the breast has been thawed thoroughly 6 feet high and 8 feet deep. In contradistinction to the firing system the thawed mass does not require to be immediately removed, the cobbles and stones in the gravel retaining the heat and doing efficient thawing 24 hours later. (The details of the working of the steam thawer were given by Douglas Waterman, who had charge of the "Points" at No. 45 above Discovery, Sulphur Creek.)

Illustration of what can be accomplished by steam thawing is readily seen from the following data showing a day's work done in the Spring of 1900 on Claim No. 46 above Discovery, Sulphur Creek. The owner, Mr. Warren, purchased and erected a 20-horsepower pipe boiler and connected up with a 1-inch steam pipe, 80 lb. pressure to supply ten points, regulation length, $\frac{1}{2}$ -inch diameter, $\frac{1}{2}$ -inch discharge.

The points were spaced three feet. The breast had 30 ft. face and the ground was thawed fully 8 feet in and to a height of 6 feet. The man in charge of the points went on shift at 6 P. M. By 10 P. M. all the points were in their full length, and were run until 5:30 A. M. the following day, when they were disconnected to drain and prevent freezing.

The expense account was as follows:

4 miners at 80 cents per hour.....	\$32.00
2 surface bucket men	16.00
1 day engineer	8.00
1 point-man	15.00
1 night fireman	8.00
$\frac{1}{2}$ cord of wood	15.00
Total	\$94.00

Work performed was: 500 buckets = 360 lb. gravel each = 180,000 lb. hoisted to surface 50 feet and discharged, costing per cubic yard \$1.69. These figures speak for themselves.

Yield and Cost per Cubic Yard.—In discussing this question of yield and cost per cubic yard, one must bear in mind the condition of the labor and supply market, at the periods mentioned. Material not available today for mining may five years from now be very remunerative as the country is developed, transportation and supplies cheapened and rates for labor lower.

The "pay streak" of today refers only to such width of channel as contains sufficient gold to stand the present enormous cost of production. It was considered in 1897-8 that ground containing less than 15 cents per pan (a pan is estimated to contain 20 lb. of gravel) was unprofitable to mine.

Labor Rates.—Though labor still remains at 80 cents to \$1 per hour (July, 1900) with the progress in mining, seven cents per pan will now pay handsomely, provided it exists in fair quantities. In a region like the Klondike subjected to many changes, fast and hard lines in the cost of production cannot be drawn. Pioneers are wedded to their own ideas, which they persist in following. In time many of their abandoned and now worked out deposits will be reopened and found profitable to work.

Experience Gained in 1897-8.—The experience of 1897-8

demonstrated the suicidal policy of the firing system of mining. The easily satisfied wants of the old prospector, and the rich placers alone permitted its use, resulting in the bulk of the gold finding its way into the hands of the Trading Companies and little accumulated by the miner.

Outside capital is gradually being invested and a few enterprises will be carried out on a scale commensurate with the requirements.

Winter work is performed at a sacrifice of energy and loss of money compared with the equivalent of labor in temperate zones, which has been attested in the hundreds of cases in the Klondike and evidenced by the numerous civil suits in Her Majesty's Courts. Mining is necessarily carried on in the dark; the costs of handling the gravel are excessive, and it is not uncommon to lose a dump by floods before it can be sluiced.

The Dumps.—The dumps represent capital expended, and the longer they lie the larger the interest account, which in a country where money draws from 2% to 10% per month, is worthy of consideration, especially where people without capital are compelled to borrow to carry on mining.

Delays.—The long tedious working season, continuous delays, slowly accumulating dumps, a late Spring, anxiety over the water, with the uncertainty of the value of the clean-up, and the knowledge of a large expense account for labor and supplies have been a nightmare to many an honest miner.

Advantages of Steam Thawing.—Steam thawing obviates these troubles; the exploration of the claim and its preparation for mining can be done most expeditiously and economically, the rapidity with which ground can be worked permits the selection of the most favorable season for mining. The simultaneous washing of the gravel enables the miner to know exactly what he can do.

A 500-foot claim, with a pay streak 60 feet wide and 6 feet deep, well managed and with a properly equipped plant, can be opened, developed, and cleaned up in 120 days from the date of the erection of the machinery, presupposing a fair water season of 60 days. Such a property will pay a handsome profit, with dirt yielding 4 cents per pan.

Conditions Requisite.—Having determined by prospecting the general course of the pay gravel in a claim (500 ft. location), five or six shafts should be located (100 or 125 feet apart) along the center line of the deposit. Two steam thawers can then be placed in position. Each plant should consist of one 35 H. P. boiler complete, as already described in this paper. One 15 H. P. hoist complete, with sheaves, ropes, buckets, two car tracks complete; one set of 10 points, necessary pipes, valves, and tools. A small circular crosscut saw, which can be attached and run by the hoisting engine, will be found an invaluable adjunct.

The thawers should be located to divide up the work evenly and be, without endangering them, as near as possible to the workings. The six shafts can be sunk simultaneously. For this work each plant will require: 1 engineer; 1 fireman; 4 laborers. One point-man for day and one for night shift will be all that is necessary for sinking and drifting.

As the shafts reach bed rock drifts should be started to connect them up. The two down-stream shafts should be connected without delay, and a sump excavated in the lower one. A bed-rock drain carefully covered and protected should as soon as practicable be cut in the bottom of the connecting drift, and its extension carried on in accordance with the requirements of the situation. Provision being always made for the pumping of the water from the lowest shaft in case drainage is required.

When the shafts have been connected, a crosscut should be run from the center of each drift, the crosscut being driven at right angles to the main drift across the width of the pay channel. A track should be placed along the main drift, and a movable turntable laid at each crossing as occasion demands. With the completion of this work and the placing of the sluices arranged for direct dumping of the gravel into them as hoisted, the claim is ready for the advent of the water season.

Method of Breasting.—The method at present followed for breasting commences work immediately at the shaft, which to say the least is in every way very objectionable. Were the deposits covered by a greater depth of material and the channel wider, a modified form of "longwall system of mining" could be worked to advantage, but the short water season, narrow channels, liability to trouble from infiltrating waters, and excessive costs in every thing, make it desirable to mine out the ground as rapidly as possible, avoiding all use of timbers, leaving the falling waste to take care of itself, keeping the drainage open and the shafts at all times secure and intact.

To accomplish this purpose breasting with thawers should commence at the intersection of the main drift and with the crosscuts. The corners are first thawed off, and gradually the largest and most convenient faces are afforded for the work. As mining progresses the work nears the pits, the gravel as excavated being

transported on trucks to the nearest respective shafts, making the longest haul say 50 feet in main drift. The handling of waste is avoided and the "muck" settles down on the bed rock as the men recede from the worked-out breasts, the track being *passu* withdrawn, and the turntables retired. Finally all that remains to be excavated is the gravel immediately around the shafts, which can be handled without danger when required. This method insures absolute security to all employed and can be expeditiously and economically carried out.

Cost of Working Claims.—On the basis suggested the following tables give an estimate of the cost of working a gravel claim in the Klondike District with a properly equipped steam thawing plant, when installed and well managed:

Estimated cost of working claim with 1 35 H. P. boiler plant, 10 points, 15 H. P. hoist. Labor rate 80 cents per hour; fuel \$20 per cord; 2 10-hour shifts:

Labor	\$9,480.00
Fuel	1,800.00
Shafts	3,160.00
Drifts	2,667.00
Sluicing	1,700.00
Management	3,000.00
	\$20,807.00

Amount gravel hoisted and sluiced, 60,000 buckets, or 1,000 buckets daily = 3,000 cubic feet = per 60-day season 6,667 cubic yards = cost of \$3.12 per cubic yard, or 162 pans per cubic yard = cost .0192 cents per pan.

Estimate of cost of working claim with 2 35 H. P. plants, 2 35 H. P. boilers, 2 15 H. P. hoists and 20 points, 2 10-hour shifts, labor and fuel rates at above prices:

Labor	\$18,960.00
Fuel	3,600.00
Shaft	2,160.00
Drifts	2,667.00
Sluicing	3,400.00
Management	3,000.00
	\$33,787.00

The output of this plant should be 360,000 cubic feet of gravel during a sixty-days season = 13,334 cubic yards, which would make the cost of mining \$2.53 per cubic yard, or .0156 cents per pan of 20 lb. of gravel. The estimate of the cost of sinking and drifting is based on the known work which can be done with the points per diem. The sinking and opening up of the claims can be readily accomplished in 60 days, making, say a total season of 4 months. The estimated cost of two such plants as referred to is placed at \$15,000. The plant could not be purchased in Dawson and placed in the mine for that figure. When the claim is worked out the plant can always be used on other claims, or sold. Their value would certainly be 50 per cent. of the original cost if sold off.

Output of Klondike Gold Field.—Through the courtesy of Chas. G. Yale, Statistician of the United States Mint, at San Francisco, I am enabled to give the figures of production of the Klondike District and show the increased yield each year since the discovery.

In 1897 the shipments of gold coming down the Yukon from the Klondike were not carefully segregated from the shipments from the camps on the American side of the boundary line, and for this reason there is no exact data at hand. The Department of the Interior, of Canada, estimated the yield of the Klondike for that year at \$2,500,000. At the United States Mint, at San Francisco, the product was estimated at \$2,000,000 which is the same figure stated by the United States Consul, at Ottawa, Canada, who considered the estimate of the Department of the Interior, of Canada, as too high.

It will be well therefore, to consider the lower estimate as correct and place the yield of 1897 at \$2,000,000.

Since that year more exact statistics have been kept. The method employed is to obtain from all United States Mints and assay offices and private refineries and smelters, the amounts received by them from the Northwest Territory. Depositors are all asked source of gold so that this record may be kept, and care is taken to avoid duplication of statements. The following record may therefore be considered reasonably correct.

1897		\$2,000,000
1898	Standard Oz.	Coining Value.
Gold	595,318.214	\$11,038,478.00
Silver	160,996.14	187,341.00
Total		\$11,225,819.00
1899	Standard Oz.	Coining Value.
Gold	859,281.228	\$15,986,627.50
Silver	229,788.95	267,390.77
Total		\$16,254,018.27
1900	Standard Oz.	Coining Value.
Gold	1,197,608.099	\$22,275,510.64
Silver	290,920.35	337,467.60
Total		\$22,612,978.24

The total output of the Klondike district (N. W. Territory) for the four years of its history is thus seen to have been \$52,092,815.51.

THE COAL FIELDS AND SEAPORTS

Of the United States—Their Locations in Relation to One Another—The Shipping Routes and Distances.

By Edward W. Parker, Statistician United States Geological Survey.

Including Alaska and Nebraska, whose commercial product is so small as to be scarcely worth mentioning, there are thirty States and Territories which contribute to our coal supply. Including both the anthracite and bituminous coal of Pennsylvania, that State alone contributes to our supply an amount more than 50 per cent. of the total product of American mines. The production of Pennsylvania is nearly equally divided between anthracite and bituminous, the former predominating each year until 1897, when, according to the returns to the United States Geological Survey, the bituminous product exceeded the anthracite by about 1,500,000 tons. By this it will be seen that of each, Pennsylvania yields 25 per cent. of the total output. Illinois is the second State in the Union in the production of coal, West Virginia third, and Ohio fourth. Following these in order are Alabama, Iowa, Maryland, Indiana, Colorado, Kansas, Kentucky, Missouri, Tennessee, and Wyoming.

These fourteen States draw their supply from four of the seven fields into which the coal areas of the United States are divided. These four coal fields are (1) the Appalachian, which extends from Pennsylvania to Alabama inclusive, and embraces, besides those two States, Ohio, Maryland, Virginia, West Virginia, Eastern Kentucky, Tennessee, and Georgia; (2) the Central, embracing Illinois, Indiana, and Western Kentucky; (3) the Western, containing the coal areas in Iowa, Kansas, Missouri, Indian Territory, Arkansas, and Texas; and (4) the Rocky Mountain field, including all the States and Territories between the Western field and the Pacific slope States. In addition to these great fields are the two small areas, one near Richmond, Virginia, and the other in Central North Carolina which are of Triassic formation and are named for that period. They are insignificant in importance compared with the other fields. There is also what is known as the Northern field, contained altogether in Michigan, and the Pacific coast field, embracing the scattered productive areas in California, Oregon, and Washington. In previous years it was customary to consider the graphite and graphitic coal of Rhode Island as anthracite coal, but this product is not used as fuel and is not included in this discussion.

A fairly accurate idea of the extent of our productive coal areas from which coal can be exported from Atlantic ports can be obtained from the accompanying map, upon which the fields have been drawn in accordance with the latest data at hand. It is the purpose of this article to indicate the relations between the sources of our supply and the seaports to which it would be sent for the use of our merchant marine and for the coaling of foreign vessels now looking to the United States for their fuel supply, and for purposes of export.

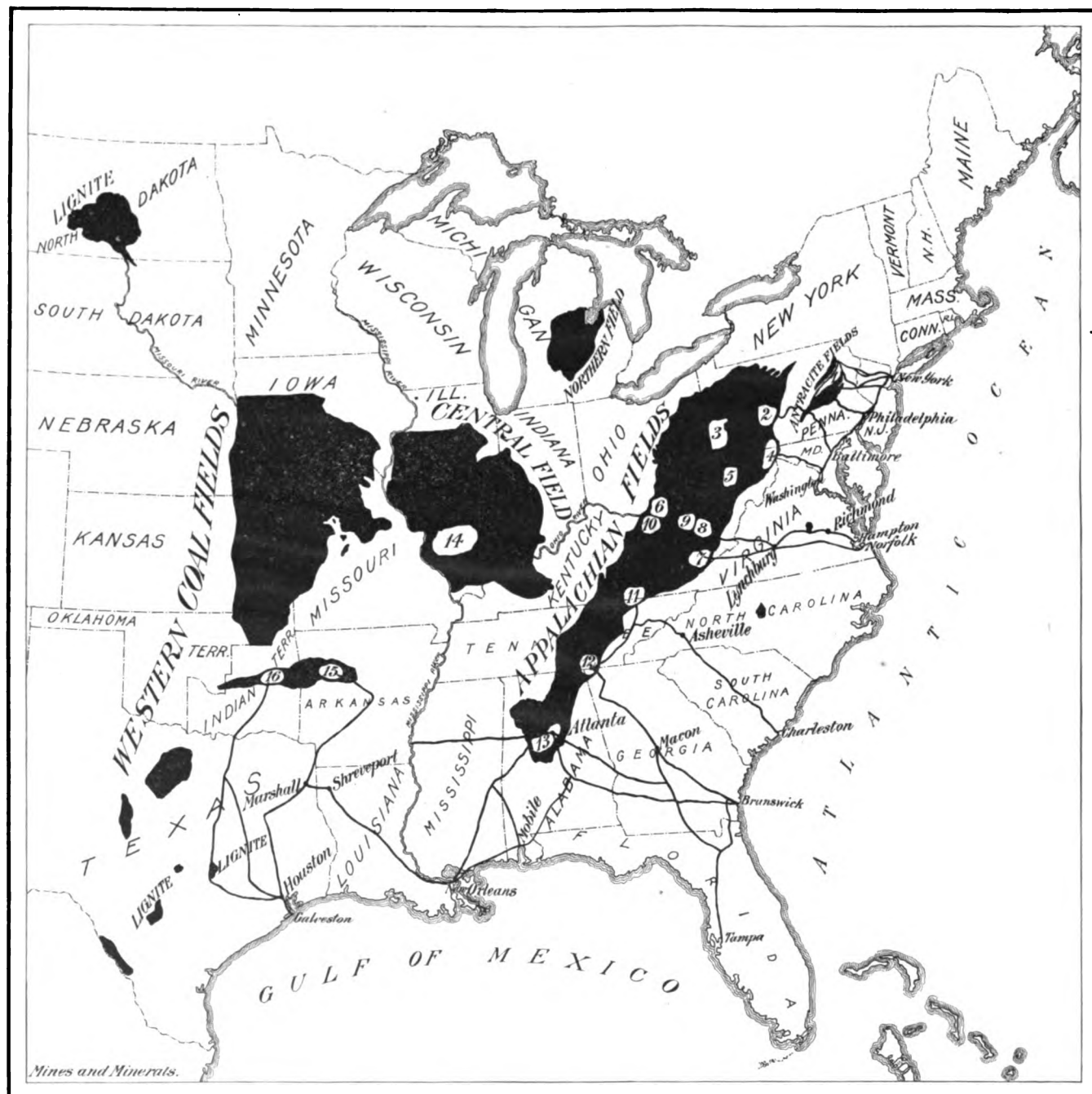
In the first place it may be well to say a few words in regard to the relative merits of anthracite and bituminous coal for steam-raising purposes. Anthracite coal, it may be stated, is bituminous coal from which the volatile contents have been driven off by heat and pressure, leaving it in the hard compact form in which it is found today. The heat was probably generated by the compression caused by some great upheaval or depression of the earth in the anthracite regions, or was due to the intrusion of igneous matter. The anthracite coal of Pennsylvania was formed under the first-mentioned conditions. Local igneous action is responsible for the anthracite fuel which occurs in scattered and limited areas in some of the Western States. Anthracite coal is in fact bituminous coal coked under enormous pressure. In some cases this process has been only partially completed, and it is then difficult to determine whether a certain coal should be classed as anthracite or not. Peat is the newest form of coal. From this it passes into lignite, from lignite into bituminous, semibituminous, semianthracite, and anthracite, there being no well-defined lines of demarkation. The entire product of the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, and Dauphin, in Pennsylvania, is however, entirely anthracite, and these counties produce all of the anthracite coal in the United States with the exception of a comparatively insignificant amount from Colorado and New Mexico.

In regard to their steam-producing qualities both anthracite and bituminous coals have their advantages. (Semibituminous and semianthracite coals, it should be remembered, are always included in the bituminous product in general discussions.) In laboratory tests one pound of anthracite coal has been found to evaporate twice as much water as one pound of bituminous coal, but this advantage is not developed in actual work under boilers. Anthracite coal burns with a much more intense heat than bituminous coal, but it is with a short flame. The long flame from

bituminous coal, caused by the combustion of its volatile gases, while not as hot as the anthracite flame will pass through the entire length of the boiler flues and thus reach a larger heating surface. Anthracite burns without smoke, which is in many cases a great advantage, but its tendency to form very hard clinkers and choke the grate bars is objectionable. Moreover, the higher the heat, the larger the amount of clinker formed. Anthracite coal being more compact, its specific gravity is higher and more of the coal, in weight, may be stowed in a steamer's bunkers. Against this may be set the higher cost per ton of anthracite as compared with bituminous. The average price for all market-

anthracite coal and some use bituminous, so that the matter of superiority is a difficult one to decide. Probably the greatest virtue possessed by anthracite coal for use in the navy lies in its safety from chemical reaction in the bunkers. What is known as spontaneous combustion never occurs with anthracite coal. Combustion of anthracite coal requires a draft of air under certain conditions such as exist in an ordinary furnace or stove.

The anthracite fields of Pennsylvania lie entirely in the eastern part of the State. As shown on the map, their area, in comparison with the bituminous fields, not only of the United States, but of Pennsylvania alone, seems absurdly small, and yet there



COAL FIELDS AND SHIPPING OUTLETS OF THE UNITED STATES.

able sizes of anthracite coal at the mines in 1897 was \$1.85 per long ton of 2,240 pounds, or \$1.65 per short ton of 2,000 pounds, while the average price for Pennsylvania bituminous coal was only 70 cents per short ton at the mines. The price per long ton for steamboat size of anthracite coal at New York harbor in 1897 was \$3.75. Georges Creek bituminous coal was \$2.60. The New York and Philadelphia harbors are practically monopolists as anthracite loading ports, while bituminous coal is easily obtainable at all Atlantic ports. Some of the ocean steamship companies use

fields produce from 25 to 30 per cent. of the entire coal output of the country, and only in very recent years has the anthracite product of Pennsylvania been less than the bituminous. It hardly seems possible that, in the three-quarters of a century that has elapsed since these fields were opened, over 1,100,000,000 long tons have been mined. Yet such is the case, and this great total is being added to at the rate of 50,000,000 tons a year. When it is considered that for every ton of coal shipped or used $1\frac{1}{2}$ tons are wasted, and that at the present rate of consumption the coal still

left in the hills will last nearly 150 years, a faint idea may be obtained of the enormous amount of fuel stored in that small area.

Outside of the anthracite fields there are certain regions in the bituminous coal-producing area whose product has achieved special reputation for steam-raising qualities. As this article is devoted to a discussion of such coals as are available for the use of the navy and for export, it is not worth while to consider further those fields which, on account of the distance from the seaboard or otherwise, would not, except under very exceptional circumstances, supply any of the fuel. For the use of the shipping on the Atlantic seaboard the coal would be drawn almost exclusively from the anthracite fields of Pennsylvania and the bituminous fields of the Appalachian Range. For supplying steamers on the Gulf coast at New Orleans or Galveston some coal might be drawn from the Indian Territory and Arkansas, and some Illinois coal would, perhaps, reach the Gulf via the Mississippi River. The various regions from which the supply would be obtained and the probable routes to the seaboard are presented in the map. The numbers indicating certain fields are used for sake of convenience in referring to them.

There are no less than eleven railroads entering the anthracite coal fields (designated by Number 1), some of which, however, do not reach the coast except by transfer to other lines. It is not possible on a map of so small a scale to trace each of these outlets. The principal transportation companies to the seaboard are the Philadelphia and Reading; Lehigh Valley; Central Railroad of New Jersey; Delaware, Lackawanna, and Western; and the Pennsylvania. The seaports in which the coal is shipped are Jersey City (including Hoboken and other cities forming part of the New York harbor), Perth Amboy, Philadelphia, and Baltimore. All of these railroads carry coal to New York; three (the Philadelphia and Reading, Central Railroad of New Jersey, and Pennsylvania Railroad) enter Philadelphia, and the same three reach Baltimore; the Pennsylvania over its own lines and the other two by connections at Philadelphia with the Baltimore and Ohio Railroad. Number 2 represents the eastern bituminous steam-coal area of Pennsylvania, including the celebrated Clearfield coal and also that of the counties in the southern part of the State. Clearfield County alone produces about 5,000,000 tons of coal annually, 2½ times the total output of Spain. The coal from this section is shipped via the Pennsylvania Railroad to New York, Philadelphia, and Baltimore, and by the Baltimore and Ohio to Locust Point, Baltimore. Number 4 designates the Cumberland or Georges Creek coal of Maryland and the Elk Garden and Upper Potomac field of West Virginia. These fields are continuous and practically the same, and should include also the Somerset and Bedford county fields of Pennsylvania. The seams of this region produce excellent steam coal and the best black-smith coal in the world. It is nearer to tidewater than any of the important bituminous coal fields, and is reached by the Baltimore and Ohio Railroad with terminal at Baltimore (Locust Point piers) or by Chesapeake and Ohio canal to Georgetown, D. C. The initial railroad from the Elk Garden portion of the field is the West Virginia Central and Pittsburg, connecting at Cumberland with the Baltimore and Ohio Railroad and the Chesapeake and Ohio canal. The production of this field is over 5,000,000 short tons annually. The Fairmont region (Number 5) directly west from the Cumberland field, produces about 2,000,000 short tons per year, the product going to tidewater eastward by the Baltimore and Ohio Railroad or it may be sent to the Ohio River at Parkersburg and thence by water to New Orleans. Going further south we find the coal field nearest to tidewater is Number 7. This is the famous steam-coal and coke-producing region known as the Pocahontas Flat Top. It includes one county, Tazewell, in Virginia, and McDowell and Mercer counties, in West Virginia. In 1880 this region was a wilderness. Development work began in 1881. The production today exceeds 4,500,000 tons a year. Its seaboard shipments go by the Norfolk and Western Railroad to Lambert's Point piers, Norfolk.

Adjoining the Pocahontas field is the New River region of West Virginia, also famous for its steam coal and coke. The railroad entering this field both east and west is the Chesapeake and Ohio, whose tidewater terminal is Newport News. The New River field includes all the mines in Fayette County. The next county to the west is Kanawha, and from here the larger part of the coal travels west and south instead of east. Some goes by rail, but that which reaches tidewater goes by the Great Kanawha, the Ohio, and the Mississippi rivers to New Orleans. At the confluence of the Kanawha and the Ohio this coal meets the Pittsburgh coal, the product of Allegheny and Washington counties, in Pennsylvania (Number 3), and the Ohio coals from the celebrated Hocking Valley and Jackson districts (Number 6), in that State. The Kanawha River region in West Virginia (including Putnam County) produces about 1,300,000 tons of coal a year. Allegheny and Washington counties, Pennsylvania, produced 12,000,000 tons in 1896, while the "panhandle," of West Virginia, properly

belonging to the district, yields about 300,000 tons more. The two Ohio districts, considered as Number 6, yield 6,000,000 tons or over every year. A little farther down the Ohio River are the coal-producing counties of Northeastern Kentucky included in Number 10. These are comparatively unimportant, producing only about 250,000 tons per year. Illinois coals (Number 14) might meet the Ohio River coals at Cairo, but it is doubtful if either Illinois or Indiana coal would be sent to New Orleans in competition with other fuels.

Coming back to the Atlantic slope, and continuing southward, the next steam-coal region is the "Jellico." This region is on the dividing line between Southeast Kentucky and Northeast Tennessee. It is designated by Number 11, and embraces the counties of Bell, Knox, and Whitley, in Kentucky, and Anderson, Campbell, and Claiborne counties in Tennessee. Jellico coal can be sent in nearly a direct line to Norfolk, but its natural outlets are at Charleston, S. C., and Brunswick, Ga., reaching the former by the Southern and the South Carolina and Georgia railroads, and the former by the Southern Railway direct. A little over 1,500,000 tons is the normal annual production of the Jellico district. Number 12, in the vicinity of Chattanooga, Tenn., is a small district containing Marion County, Tennessee, and Dade and Walker counties, Georgia. From this region is obtained what is known as "Chickamauga" coal whose reputation as a steam producer is well established. This coal has a direct outlet to Brunswick over the Southern R. R., or to Tampa, Fla., by connection with the Plant system. In comparison with some of the other fields the last two mentioned are not large producers, but the quality of the fuel is excellent and their proximity to southern seaports gives them prominence. Then come the Alabama fields all of which have been included in Number 13. Three counties, Bibb, Jefferson, and Walker produce over 90 per cent. of the total output of the State, which in 1897 was nearly 6,000,000 tons. Four seaports are easily accessible from this region, Brunswick, Tampa, Mobile, and New Orleans. The last mentioned is reached by three routes, one by rail to Greenville, Miss., and thence by Mississippi River, the other two all rail by the Southern and the New Orleans and the North Eastern, or via the Western, of Alabama, and Louisville and Nashville, as shown on the map. Finally we have in the Southwest the excellent fuels of Arkansas and Indian Territory, Numbers 15 and 16, with a combined output of about 2,000,000 tons. The former can reach New Orleans by two routes, one partly by the Mississippi River, the other by the St. Louis, Iron Mountain and Southern, and the Texas and Pacific railroads via Shreveport. By connection with the International and Great Northern Railroad the Arkansas coals reach Galveston. The Indian Territory coals also reach Galveston going by the Missouri, Kansas and Texas Railroad direct or by connection of this road and the Houston and Texas Central at Sherman, Texas.

The following statement indicates approximately the distance our mineral fuels travel in going from the mines to the seaboard. The names of some of the important shipping points are given, the points of destination and the routes traveled. In some cases two shipping points are given; for instance, on the Delaware, Lackawanna and Western railroad the town of Northumberland is the anthracite shipping point farthest from the seaboard, being 225 miles from Hoboken. Scranton, however, at the eastern end of the field is 80 miles nearer tidewater and only 145 miles from Hoboken. The average distance would be 185 miles. By the Central Railroad of New Jersey and Mauch Chunk is only 119 miles. The anthracite fields are nearer to tidewater than any of the bituminous fields except the small one near Richmond. The initial point nearest to New York harbor is Mauch Chunk 119 miles. Pottsville is only 92 miles from Philadelphia, and from Sunbury to Baltimore the distance is 138 miles via the Northern Central division of the Pennsylvania Railroad. The Cumberland and Elk Garden fields of Maryland and West Virginia, are the bituminous areas nearest tidewater, the distance from Piedmont to Baltimore via the Baltimore and Ohio Railroad being 205 miles, while Altoona on the eastern edge of the Pennsylvania bituminous fields is 217 miles from Baltimore and 237 miles from Philadelphia.

ANTHRACITE—REGION NO 1.

Shipped.	To.	Via.	Distance. Miles.
Northumberland	Hoboken, N. J.	Delaware, Lackawanna & Western Railroad	225
Scranton	Hoboken, N. J.	Delaware, Lackawanna & Western Railroad	145
Scranton	Jersey City	Central R. R. of New Jersey	192
Mauch Chunk	Jersey City	Central R. R. of New Jersey	119
Sunbury	Jersey City	Philadelphia & Reading	248
Sunbury	Philadelphia	Philadelphia & Reading	158
Pottsville	Philadelphia	Philadelphia & Reading	92
Pottsville	Jersey City	Philadelphia & Reading	185
Shamokin	Perth Amboy	Lehigh Valley	160
Mauch Chunk	Perth Amboy	Lehigh Valley	107
Pottsville	Philadelphia	Pennsylvania R. R.	95
Scranton	Baltimore	Pennsylvania R. R.	220
Sunbury	Baltimore	Pennsylvania R. R.	138

BITUMINOUS—REGION No. 2.

Shipped.	To.	Via.	Distance. Miles.
Altoona	Philadelphia	Pennsylvania R. R.	237
Altoona	Baltimore	Pennsylvania R. R.	217
Berlin	Baltimore	Baltimore & Ohio R. R.	216
REGION No. 4.			
Piedmont	Baltimore	Baltimore & Ohio R. R.	205
Elk Garden	Georgetown, D.C.	W. Va., C. & P. R. R. and Ches. & Ohio Canal	238
REGION No. 5.			
Fairmont	Baltimore	Baltimore & Ohio R. R.	300
REGION No. 7.			
Pocahontas	Norfolk	Norfolk & Western R. R.	375
REGION No. 8.			
Thurmond	Newport News	Chesapeake & Ohio R. R., via James River Division.	420
REGION No. 9.			
Handley	Newport News	Chesapeake & Ohio R. R.	458
REGION No. 11.			
Jellico	Charleston	Southern Railway & South Carolina & Georgia R. R.	487
Jellico	Brunswick	Southern Ry.	580
Jellico	Port Tampa	Southern Ry. and connections	844
REGION No. 12.			
Chattanooga	Brunswick	Southern Ry.	404
Chattanooga	Port Tampa	Southern Ry. and connections	668
REGION No. 13.			
Birmingham	Brunswick	Southern Ry.	445
Birmingham	Port Tampa	Central R. R. of Georgia or Louisville & Nashville and connections	680
Birmingham	Mobile	Louisville & Nashville R. R.	275
Tuscaloosa	Mobile	Ala. Great Southern Mobile & Ohio R. R.'s.	232
Birmingham	New Orleans	Louisville & Nashville R. R. or Southern Ry.	400
Birmingham	New Orleans	Southern Ry. & Mississippi River. Rail	291
Coal Hill, Ark.	New Orleans	St. Louis, Iron Mountain & Southern and Texas Pacific R. R.'s.	240
Coal Hill, Ark.	Galveston	St. Louis, Iron Mountain & Southern and International & Great Northern R. R.'s.	700
REGION No. 16.			
McAlester, I. T.	Galveston	Missouri, Kansas & Tex. R. R.	590
McAlester, I. T.	Galveston	Missouri, Kansas & Texas, and Houston & Tex. Central R. R.	485
Hartshorne	Galveston	Choctaw, Oklahoma & Gulf; Missouri, Kansas & Texas; Houston & Tex. Central R. R.	500
BITUMINOUS—WATER ROUTES.			
Pittsburg	New Orleans	Ohio & Mississippi Rivers.	1,965
REGION No. 6.			
Portsmouth, Ohio	New Orleans	Ohio & Mississippi Rivers.	1,611
REGION No. 9.			
Kanawha, Dam No. 4	New Orleans	Kanawha, Ohio & Mississippi Rivers	1,773
REGION No. 10.			
Ashland, Ky.	New Orleans	Ohio & Mississippi Rivers	1,645
REGION No. 14.			
Central Illinois	New Orleans	Rail to St. Louis—average	100
Central Illinois	via St. Louis	Mississippi River	1,200
Central Illinois	New Orleans	Rail to Cairo—average	175
Central Illinois	via Cairo	Mississippi River	1,000

Ventilating the Elkhorn Tunnel.

The Railroad Gazette, for May 10, contains a most interesting article upon the ventilation of Elkhorn Tunnel, by Mr. Charles S. Churchill, Engr. M. & W. of the Norfolk & Western Railway, from which the following abstract is made. The tunnel is about 3,000 ft. long with a grade of 1.4%. In hauling over the up grade two and sometimes three engines are required and the amount of gas and smoke emitted is naturally very great. The tunnel before its ventilation became at times very warm and the conditions to which the trainmen were subjected were, to say the least, unpleasant. In order to secure the desired improvement an air chamber was formed in the side walls and roof of the tunnel at its lowest or west portal, thus forming in fact the nozzle of an injector. This chamber was gradually tapered from the entrance to the blast opening and into this chamber air is forced by blowers which consist of two fans 14 ft. in diameter each operated by an engine of 75 H. P., both fans and engine being built by the B. F. Sturtevant Co., of Boston, Mass. The rated delivery of each fan at 1 ounce pressure, or 118 revolutions, is 168,588 cu. ft. per minute. The essential object of this arrangement is to create a current of air through the tunnel by blowing a blast of air through it and away from the ventilating apparatus and at a rate of speed sufficiently great to clear the foul air from the tunnel in a reasonably short time. Notes taken of the condition of the air in the tunnel prior to its ventilation showed that in summer 17 to 55 minutes were required to give it time to clear after the passage of a train. The shortest time noted was in winter, when the average time was about 20 minutes, though frequently much longer. Each train

had then generally not only its own smoke to contend with, but that of one or more previous trains. The temperature inside the tunnel became about 30° higher than the outside temperature on the passage of a train.

Numerous tests of the improved system were made during the month of April last. In one of these taken under the most trying conditions a three-engine east bound train of coal passed through the tunnel in six minutes, while the fans were running at 142 revolutions per minute, boiler pressure 102 lb. The observer on the first engine rode on the tank, and the engineer had the windows of the cab open. He reported the tunnel entirely clear two-thirds of the way through and no objectionable smoke anywhere. The enginemen reported the tunnel O. K. An observer at the east portal reported that the smoke of the train came out two minutes ahead of the first engine. The observer on the second engine rode in the cab with all windows open. He could see the smoke of his engine seven cars ahead of his engine; no smoke behind the tank; tunnel clear at the engine, and cool. The observer on the rear engine rode in the cab with windows open; he found the tunnel practically clear and no smoke behind showing that fresh air was with his engine throughout. A small amount of steam adhered to the roof of the brick work near the east portal, but this passed out in about one minute after the engine passed out. The reports of the enginemen agreed with these as to clear and cool tunnel.

All of these results were secured without any reduction of the area of tunnel, which, in this country is regarded always as very undesirable; they are accomplished in a positive and perfectly controllable manner as compared with the variable results from the use of fans and shafts; and, finally any desired amount of fresh air can be delivered at such speed as may be necessary to suit the traffic.

Test of Flattened Strand Cable.

A number of engineers recently examined the cables of elevator No. 1 of the Bank of Commerce Building, St. Louis, Mo., and found that after five and a half years of continual service the inside strands were in as good condition as the day they were made.

The test was made at the invitation of the A. Leschen & Sons' Rope Co., of St. Louis, the manufacturers in America of the patent flattened strand wire rope, and was undertaken to see whether the oval center of the five stands cut the inside wires. The examination proved that the wires were not even indented by the oval or flattened strand.

This rope is an English invention, and some years ago the firm secured the sole right of American manufacture. At once it was attacked by competing rope companies on the ground that the flat center would cut the inside wires, leaving the outside in good condition, thus making it dangerous. The makers claim that the flattened strand causes all of the outside wires to rest evenly on pulleys or wheels, and that this gives 150 per cent. more service than any round strand wire rope.

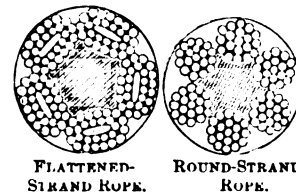
Engineer James H. McCord, of the Bank of Commerce building, discovered that some of the outside strands of the elevator rope were broken, and ordered a new cable. The manufacturers thought this would be a good opportunity to test practically the claim that their patent strand cut the inside wires, and invited 40 of the prominent engineers of the city to examine the rope for themselves. The old rope was cut to pieces and carefully examined by them and, even at the point where through constant wear the outside strands had parted, the inside strands were found to be perfect.

After the examination a luncheon was served where Mr. McCord told the company of his experience with the wire, saying that all other cables he had used lasted but three years, and concluded with the statement that he had replaced the old cable with one of the same kind.

Mr. J. H. Joyce, engineer of the Telephone Building, in a brief address, said that he had bought one of the cables under discussion, and that it has now been in service three years and one month, and that the longest service he had ever secured with those elevators with a round cable was two years.

Slate Ground for Pigment.

Including "mineral black," a pigment made from the slate partings and roofs in anthracite collieries, the amount of slate and shale ground for paint in 1899 in the U. S. amounted to 4,676 short tons, valued at \$43,673, indicating a gain in amount of 105 tons over 1898, and a loss in value of \$2,512.



THE SECONDARY ENRICHMENT

Of Ore Deposits—Influences Causing Comparatively Rich Sulphide Deposits in Certain Zones.

By S. F. Emmons and W. Weed.*

A clear distinction was made by the late Professor Posepny between the influence upon ore deposits of water descending from the surface and that of deep underground waters ascending from the depths under the influence of heat. Professor Penrose later treated the effect of oxidizing waters in his "Superficial Alteration of ore deposits." Mr. Emmons in his researches at Leadville dealt with oxidized forms found at the surface. That these were the result of alteration of earlier sulphides was later proven by deeper development, Leadville having changed from a "carbonate" to the sulphide camp it is at present. He now considers that under favorable conditions oxidation products may be again changed into sulphides and be redeposited as such.

Rich deposits both of copper and silver ores may be the result of secondary enrichment, and mineral veins may be enriched by later metallic sulphides. Many instances have been met of oxidizing action below the ground-water level. In Leadville there were cases of zinc being removed from its presence in the carbonate surface ores and redeposited as a sulphide just below the line of complete oxidation by surface waters.

In the Butte region, Dr. Douglas says, "It seems as if the copper leached out of the 400 feet of vein depleted near the surface had been concentrated in the underlying ore and had thus produced a zone of secondary ore 200 feet deep, containing thrice its normal copper contents."

The conditions at Butte, Montana, are first, indications of several successive rock fracturing movements, and a series of secondary fractures besides and after those containing the original vein. These secondary fissures were later, as they contain rounded fragments in them of the original vein. The original ores of the vein are quartz, pyrite, chalcopryite and enargite. The richer sulphides, bornite, chalcocite and covellite are of later origin.

The prominent characteristics of the Butte copper lodes are:

First.—An oxidized upper zone, extending down 200 to 400 feet containing less than 1 per cent. copper, the values being principally in silver. It is a mass of crumbling quartz, honey-combed and free from metallic oxides.

Second.—Below this an ill-defined zone of very valuable copper sulphides, bornite, chalcocite and chalcopryite, the proportion of richness decreasing with depth, till the ores become only pyrite and chalcopryite. Enormous amounts of copper glance are found in some of the mines in the upper levels of the sulphide zone, solid masses fifteen feet thick containing a little pyrite and chalcopryite and some native silver. One or more secondary fractures are always found in the immediate neighborhood of these rich or enriched ores.

Covellite, a rare deep blue copper mineral, was found at a depth of 1,100 feet in a mass of breccia. There seems a connection between these secondary fractures and the rich copper sulphides. These sulphides are considered to be enrichments of the earlier vein deposits by solutions following the water channels afforded by secondary fractures. Was this enrichment produced by surface or by deep underground waters?

The deposits of Butte are exceptional in the depth to which the richer copper sulphides have been found to extend. The occurrence of a belt of rich sulphides immediately below the water level is by no means universal.

Numerous examples are cited from Western regions of the enrichment of ores of copper apparently in a secondary way below or near water level.

From these investigations Mr. Emmons concludes:

First.—That descending water not only causes transference and reconcentration of the alteration products of the original vein materials in oxidized form, enriching in one place and in another possibly impoverishing, but in their further downward course the oxidized forms are frequently reduced and redeposited as sulphides, thereby producing a sulphide enrichment of the original vein materials.

Second.—That this secondary enrichment of sulphides is not necessarily a reduction in the presence of organic matter, but may occur where organic matter is absent, mainly in contact with the original sulphides of the deposit, as a result of chemical reaction between these sulphides and the materials brought down in solution by the descending waters.

Third.—While this redeposition of sulphides in many cases appears to commence at or near the ground water level, it does not appear to have a necessary connection with that level, and

may extend below that level by means of post-mineral fractures, admitting a free and uninterrupted descent of the waters.

It is well in this connection to consider the processes that have taken place and other changes since an ore deposit was originally formed and before it reached its present condition, such as rock shatterings connected with earth movements, which have opened channels for the entrance of surface waters within the rock mass, and extended the areas to which the chemical actions produced by the latter may have extended. Second, erosion or denudation which has worn down the original surface to its present configuration so that parts of a once deep-seated ore deposit have approached near the surface. The amount of rock overlying the ore bodies removed by denudation may be very great. As much as 10,000 feet thickness of rocks at Leadville, Emmons estimates, was worn away from above the present deposits.

In the Butte district, the later shattering of the rocks produced abundant secondary fissures nearly coincident with the earlier ones. The conditions, therefore, were very favorable for an abundant leaching down of the material taken up in a solution by surface waters.

The vein at Butte may be divided into 3 horizontal zones.

First.—An upper surface zone of most recent oxidation.

Second.—An immediate zone of oxide enrichment. The less soluble metals brought down from the zone above are found as carbonates or oxides or as native metals.

Third.—Zone of sulphide enrichment, materials brought down in solution and not deposited in zone next above are deposited as sulphides or native metals, in contact with the original sulphides of the deposit.

These zones may run into one another and with progressive denudation a lower zone is slowly changing to the one above so that constantly a richer zone rises to the surface to be oxidized and has part of its oxidation products carried back and redeposited as oxides or sulphides, so the longer a deposit has been subjected to denudation the greater will be the enrichment below the surface zone.

To go into the chemical processes involved would be beyond the limits of this epitome.

Mr. W. Weed puts special emphasis upon the dependence of enrichments on the presence of iron sulphide (pyrite) in the primary ore and upon structural features which control the circulation of the enriching solutions below the water level. It is believed that many, though not all, of the bonanzas and pay chutes of rich sulphide ores, especially those carrying gold and silver, which are encountered in ore deposits are of such secondary origin.

It is essential that the occurrence and structural relations of such ore masses should be understood as the success of the mine, is often dependent upon the finding and extraction of these ores. Such ore deposits are likely to decrease in value with depth.

The fact that masses of very rich ore often occur near the water level in many mines, but do not continue in depth and the occurrence of pay streaks and bonanzas in deep mine work is well known in many regions. Such ores are enriched from bodies of lean ore of complex composition which have been lixiviated, the gold, silver and copper carried downward below water level and precipitated as high grade sulphide ores.

Surface waters have leached these lean ores and the metallic contents have been carried down and leached. Concentration has also been effected by new fractures, serving as channels for up-coming hot waters.

In the surface zone of weathering the enriched material is derived by leaching out of metals from the portion of the vein lying above ground water level. This leaching is due to superficial alteration and leaves the iron as a goossan, while the waters carrying the gold, silver, copper and other metals in solution trickle downwards through the partially altered ores into cracks and water courses, which penetrate the ore body below the water level.

Not all the material leached out in the zone of weathering migrates below to the zone of enrichment, but takes the form of oxides and carbonates of the metals.

In the zone of enrichment the surface waters which have leached the vein in the zone of weathering seep downward along cracks and crevices into the primary ore below.

Penetrating the primary ore they come in contact with the unaltered metallic sulphides. In such masses pyrite is often abundant and a reaction at once occurs between the iron sulphide and the metallic salts (sulphate) held in solution, decomposing them and precipitating new sulphides which encrust the walls of the fractures.

In gold deposits it is assumed that the unaltered pyrite contains the ore which is altered to a rusty mass of sesquioxide of iron, permeating the quartz and holding nugget-threads of free-gold.

By further alteration the iron is leached out and a porous,

* Abstract from paper read before the American Institute of Mining Engineers, Feb., 1900.

spongy, honey-combed white quartz remains holding the gold. Part of the gold, however, may be taken into solution by ferric sulphate and carried downwards as the waters seep below, and precipitated as native leaf wire or scale gold in minute cracks in sulphide ores or deposited with antimonial silver as ruby silver.

In the Ruby Mine at Butte such ruby silver occurs. This mine yielded \$600,000 in less than a year, of which half was gold. The ore was a secondary concentration along a clay-filled fault fissure, which is now exhausted.

The so-called "indicators" of Australia are thin layers but half an inch thick of pyrite in shale, and quartz veins are barren except where they intersect these pyritous layers.

Gold is precipitated from solution more readily by metallic sulphides than by organic matter. Pyrite is the great precipitant of secondary sulphides.

Mr. Weed then cites a great number of examples in proof of his hypothesis. His deductions are that enrichment depends largely on the presence of iron pyrite or iron sulphide in the primary ore. Hence ore bodies lacking in iron pyrite will not show enrichment, hence there is no such secondary enrichment in the pure silver-lead bodies of the Coeur d'Alene district and elsewhere.

If the primary ore body is shattered by cracks, sheeted by later movement or traversed by secondary fractures, such crevices will be the channels in which the descending solutions will travel and along which secondary ores will form deposits in unaltered ore below.

Such secondary fractures may be filled with quartz or barren and open or filled with clay or breccia. So-called stringers or feeders of a vein are often of this secondary nature and origin. Some lodes are only ore-bearing at the juncture of these secondary cross-veins.

At Butte, Montana, these fractures are extensive and the enrichment due to them extends to a depth of 2,000 feet. In the Neihart the zone of secondary enrichment has yielded ores running 200 to 1,000 ounces silver to the ton. These ores gave out in depth, causing disappointment and failure. This alone shows the importance of considering well this phenomenon of possible secondary enrichment at a certain zone in a mine, and possible impoverishment above with only ordinary values below that zone.

Enrichments are often favored by high altitudes owing to the rapid degradation or erosion of the country, bringing the ores within reach of enrichment processes and the quick lixiviation of ores near the surface. Prolonged degradation is for a similar reason favorable.

The Vancouver Coal Mines.

By A. E. Smith, U. S. Consul at Victoria.

The most important factors in the prosperity of Vancouver Island are the rich coal mines that have been developed all along its eastern coast that give employment and livelihood to thousands of people.

Until of late years, the Vancouver Island mines have had no rivals in British Columbia and have practically monopolized the coal trade. But the development of the Crow's Nest coal mines in the southeast portion of the Province, recently purchased by an American syndicate, now in control, has prevented any increase of the consumption of Vancouver Island coal on the mainland, though it is claimed that the Canadian Pacific Railroad, which still uses the island coal, regards it as superior for making steam to the product of the Crow's Nest mines. It is stated that the Crow's Nest mines are the largest on the coast; capable of producing, when properly worked, 10,000 tons of coal daily, and even at that rate of lasting several hundred years. The present product of these mines amounts to less than 1,000 tons per day, and cannot be largely increased until a way is found to reach the United States. A bill is now before the Legislature and the Dominion Parliament asking a charter for a railroad from Michel, British Columbia, to the international boundary, where connection is made with the Great Northern Railroad. The company is ready to build the road without bonus or land grant of any kind, but is, of course, opposed in their application for charter by the Canadian Pacific Railroad, aided by parties who oppose all roads that lead to the United States.

There has been quite a change in the mines of Vancouver Island during the past year. The coal mines at Comox, the most northern, have been worked to their fullest capacity and one or two new shafts dug out. It was in one of these new shafts (No. 6) that a terrible explosion took place on Friday, February 15, 1901, by which sixty-four miners, all who were working in the shaft, lost their lives. Of the dead miners, twenty were whites and the remainder Asiatics. Since then work has been resumed, and the mine is again being run to its full capacity.

At Wellington the mines have been worked out and abandoned—and so has the town itself, practically. Before the work

ceased there were frequent "cave-ins," involving loss of life and property. During the past year, the principal buildings there have been moved away to other towns, and, by petition of the remaining inhabitants, the municipal charter has been surrendered and revoked. The repair shops of the Esquimalt and Nanaimo Railway, however, still remain there. It is understood that if the road is continued north to Hardy Bay, the shops will be kept at Wellington. A charter has been applied for to authorize the extension of the railroad, which will probably be granted; but whether the road will be built is yet to be determined.

The mines at Nanaimo, extending from the town under the bay to Protection Island, are worked to their full capacity, and ship as much coal as all the other mines of the island combined. These mines are worked entirely by union men, and no Asiatics are employed underground. The result is that Nanaimo is represented in the provincial legislature by two labor men, while the seat in the Dominion Parliament is filled by the secretary of the miners' union. Strikes have so far been avoided, although one was set for March 1, 1901; but the management met the committee representing the miners and showed the contracts of the company, many of which were made before the present provincial tax of 5 cents per ton was levied, and the men have so far continued without increase. In these mines, the miners receive 68 cents per ton and make an average of \$4 to 4.60 per day.

The Alexandria mine is closed, and has been since last December. The management gives as reason for closing that there is no demand for the coal, which was chiefly sent to San Francisco. Since that time, the whole force of 180 men previously employed in the mine has been lying idle, save those who have gone to work in other mines. The miners claim that the real cause for closing the mine is that the management insisted that 2,800 pounds should constitute a miner's ton, instead of 2,352 pounds, as had previously been the rule; and, further, that nothing should be allowed for "turning places," which are quite numerous in this mine. The management states that the United States duty of 67 cents per ton, the 5-cent tax, the eight-hour law, and the discovery of oil in California render the market unprofitable; and further intimates that the general output of Vancouver Island coal mines may have to be curtailed in the near future, owing to the competition of the Washington mines, and of California oil. A number of the unemployed and their families are now receiving relief from the Nanaimo and other unions.

The Extension mines, owned by the same company (the Wellington Colliery Company), are distant 12 miles only from the Alexandria. It may be stated that all the coal mines of the island are on the east coast, within a radius of less than 40 miles. The Extension mines are running as usual and frequently are unable to supply the demand for coal, vessels having to wait their turn at the wharves before receiving their needed supply. Forty or more of the miners who formerly worked at Alexandria have secured work in the Extension mines, where 72 cents per ton is paid miners, against 66 cents in the Alexandria mine.

The operation of the Extension mines has resulted in the building and incorporation of a new town at Oyster Bay, known as Ladysmith, which already has 1,200 inhabitants, several stores, hotels, etc., and bids fair to become a thriving city; although entirely dependent, as was Wellington, and as are Nanaimo and South Wellington, on the mining industry. Here, bunkers capable of holding 20,000 tons of coal have been erected, and tracks run direct to the wharves from the mines at Extension, 14 miles away. Many of the miners reside in small shanties close to the mine, but the management prefers to have them live at Ladysmith. To this end, lots are sold miners for \$100 each and neat cottages erected for them, payable on the installment plan. Trains run at convenient hours for the different shifts of miners, and transportation is without cost. All the men are paid at Ladysmith, which is the headquarters of the management of Extension mines.

Exposition Information Bureau.

It will be of interest to readers who will visit the Pan-American Exposition, to know that The International Correspondence Schools, Scranton, Pa., have established an information bureau at their Buffalo Office. Arrangements have been made to secure accommodations both in hotels and private families during the Exposition. No rooms can be secured at less than \$1 per night for each person and persons wishing rooms held for them must forward remittance to pay for the time the rooms are wanted. The information bureau is conducted free of charge and it is hoped that all engineers and friends of MINES AND MINERALS will avail themselves of its privileges. All correspondence intended for the information bureau should be addressed to The International Correspondence Schools, Ellicott Square Building, Buffalo, N. Y., and students and others visiting the exposition are invited to call at that office. They can be assured of a cordial reception and every effort will be made to make their stay interesting.

ORIGIN OF PETROLEUM.

A Statement of Various Theories Which Have Been Proposed and Some of the Facts in Support of Them.

Our knowledge as to the conditions of the occurrence of petroleum and natural gas in the rocks has been very greatly extended within a few years, and while various theories have been put forward from time to time to explain the occurrence and origin of these substances there is no one theory that has yet been universally accepted.

The theories as to the origin of petroleum may be divided into two general classes, 1st those which attribute to it an inorganic origin; and 2d, those which attribute to it an organic origin.

It should be stated before describing some of the more common and apparently most plausible theories, that the trend of modern thought is toward the second class of theories, or the theories which attribute the origin of petroleum to an organic source. It is of interest, however, to briefly state several of the inorganic theories as they have been advanced by well-known and celebrated scientists.

Humboldt in 1804 advanced a theory that oil was distilled from depths far below its present horizon by volcanic action. This theory has had other supporters, and is based on the fact that a number of the gases issuing from volcanoes are carbon compounds. This theory is flatly controverted in America from the fact that the deposits of oil are far removed from the scene of volcanic action.

Berthelot's theory, proposed in 1866 by the distinguished French chemist, supposed the alkali metals, viz.: potassium and carbon, to exist in the interior of the earth necessarily at a high temperature. Berthelot traced out the chemical changes which would take place if water charged with carbonic acid came into contact with these heated alkali metals, and in this way he explains the formation of the hydrocarbon compounds.

Mendeleff's theory, advanced in 1877 by the eminent Russian chemist, is somewhat similar to that of Berthelot. He supposed the interior of the earth to contain large masses of metallic iron and metallic carbides, all at a high temperature. He explains the formation of petroleum by the contact of water with these heated metallic bodies, which contact would produce metallic oxides and hydrocarbons.

These theories must probably forever remain hypotheses, as the conditions are such that they can probably never be verified.

THEORIES OF ORGANIC ORIGIN.

According to these theories, petroleum and natural gas are derived from vegetable and animal matter contained in the rocks in which they are found, or in associated strata. In support of these theories, compounds similar to, or identical with, petroleum and natural gas are easily derived by a process of destructive distillation from both vegetable and animal substances. While this general fact cannot be controverted, and while it seems to be the true basis upon which a theory should be built, there are numerous explanations based upon the general theory, which differ widely in regard to the details of the general theory. Some for instance claim that all petroleum comes from animal remains, others claim that all of it comes from vegetable remains, while still others attempt to show that all of it comes from sea vegetation or sea animals, and still others that it all comes from land vegetation or land animals. It is probable that no one of these theories will explain all of the phenomena connected with the formation of petroleum, and that each one of them has some truth in it. It is also quite probable that different deposits of petroleum, have been formed in different ways. Leo Lesquereux for instance thought that Pennsylvania petroleum was formed from marine algae, and he assumed petroleum to be the result of the decomposition of marine plants, as coal is the result of land plants. Mr. G. P. Wall assumes petroleum to be formed by the decomposition of vegetable matter entirely similarly to the formation of coal, the change being one of degree rather than of kind. He mentions having found woody fibers and tissues in the asphaltum of Trinidad Lake, while another person claims to have found evidences of animal remains in the same deposit. If both of these finds are authentic they tend to show that neither theory will account by itself for the Trinidad formation, and would seem to indicate that both animal and vegetable remains may have played a part in the formation of this remarkable deposit.

One form of the organic theory claims that petroleum and natural gas have been distilled from carbonaceous deposits and then caught and retained in overlying porous strata. In confirmation of this theory, it is well known that petroleum very closely resembles "coal oil" which is distilled from coal, peat, etc., but opposed to it is the fact that the deposits of coal and oil are frequently found widely separated, and so far as we know many of the deposits of oil and gas are situated entirely away

from any carbonaceous deposits from which they might have been distilled. In this connection, Dr. Sterry Hunt points out that porous strata not containing petroleum are found between similar strata which are saturated with it, so that the petroleum could not have been derived from overlying or underlying beds, but must have been generated in the strata in which it is found at the present time.

One of the most ardent advocates of the distillation theory is the well-known petroleum expert, Prof. Peckham, who thought that the different varieties of petroleum are the products of slow fractional distillation, without intense heat, of carbonaceous matter contained in rocks far below those which now yield the oil. This theory he applied particularly to the deposits of New York, Pennsylvania, Ohio, and West Virginia. He attributes the heat to metamorphic action incident to the Appalachian uplift, and thinks that the process of distillation set up by heat thus generated converts animal and plant remains into oil, the lighter oils into the heavy oils, and these in turn into solid bitumens such as asphalt, the whole process being accompanied by an evolution of gas. While Prof. Peckham explained the origin of Pennsylvania, Ohio, New York, and West Virginia petroleum in this way, and thinks that the original organic remains were plant life, he thought that the petroleum of California and Texas were formed from animal remains in the same shales in which the deposits are at present found.

A large number of the German chemists seem inclined to the belief that petroleum has come from the distillation or decomposition of animal remains, and in support of their belief, they cite the result of experiments of Prof. Carl Engler, of Stuttgart, and others, by which these experimentors have produced from fish remains a series of compounds which are practically identical with the petroleum compounds found in nature.

Those who wish to go into the full details of the investigations which have been made in this interesting subject are referred to the very elaborate report by Dr. Edward Orton, late state geologist of Ohio, Volume VI of the Economic Geology Reports of the Geological Survey of Ohio, in which he gives the argument in favor of a number of the different theories very fully. We will simply quote Dr. Orton's conclusions upon this matter, which are as follows: "Petroleum is undoubtedly indigenous to, and derived from, certain limestones, as Hunt has so strongly asserted. The Trenton limestone is undoubtedly the most important source of oil and gas in the geological scale of the United States at the present time. On the other hand, Newberry's doctrine, that the great supplies of the Pennsylvania field are derived from Devonian shales, is becoming more firmly established and more generally accepted every year, though it seems likely that he has laid too much stress on bituminous shales. In other words, the theories are not exclusive of each other. Different fields have different sources. We can accept, without inconsistency, the adventitious origin of the oil in Pennsylvania sandstones, and its indigenous origin in the shales of California, or in the limestones of Canada, Kentucky, or Ohio.

"The double origin of petroleum, from both limestones and shales—and it is not necessary to exclude sandstones from the list of possible sources—deserves to be universally accepted. In confirmation of this double origin, it is coming to be recognized that the oil and gas derived from limestones contain larger proportions of sulphur than is found in the oil and gas of the shales. Sulphur compounds impart to the oil a rank and persistent odor, from which they can be freed only with great difficulty. In the case of the oil-bearing shales of California, the petroleum is apparently derived from animal remains with which the formation was originally filled. In composition, this oil agrees with the limestone oils already described." His theories may be summed up as follows: 1st, Petroleum is derived from organic matter. 2d, Petroleum of the Pennsylvania type is derived from the organic matter of bituminous shales, and is probably of vegetable origin. 3d, Petroleum of the Canadian type is derived from limestones, and is probably of animal origin. 4th, Petroleum has been produced at normal rock temperatures (in the American fields), and is not a product of destructive distillation of bituminous shales.

The latest inorganic theory to be advanced is that of Henry Moissan, the well-known French experimenter with the electric furnace, particularly in connection with the carbon compounds and the reactions between the metals and carbon. In his book "Electric Furnaces," published in 1897, he says in regard to the formation of petroleum: "The reaction that appeared to us most wonderful was the ease with which we could produce gaseous, liquid or solid hydrocarbons by the action of cold water on certain metal carbides." The action of water upon aluminum carbide gave pure methane and "might be the cause" for the occurrence of natural gas issuing from the earth in certain localities and streams continuing for hundreds of years. "A similar reaction may serve to explain the formation of liquid

hydrocarbons or petroleum. In a single experiment we received 100 grams of liquid hydrocarbons from 4 kilograms of uranium carbide. To a great extent this mixture is composed of the ethane series and only a very small per cent. of the acetylene series. At the same time under ordinary pressure we received considerable hydrogen and methane. This led to the belief that under pressure we would have nothing but the methane or saturated series similar to petroleum. Doubtless during the early period of the world's existence the entire carbon was combined in the form of metal carbides. A sudden movement of the earth's crust would permit water to come in contact with these metal carbides and produce a sudden evolution of gas. The temperature would rise and produce polymerization of the hydrocarbons and thus produce a very complicated mixture of these compounds. Through existence of metallic carbides, produced so readily by means of high temperatures, which are doubtless found in the earth's interior, one could readily account for the existence of gaseous, liquid and solid hydrocarbons."

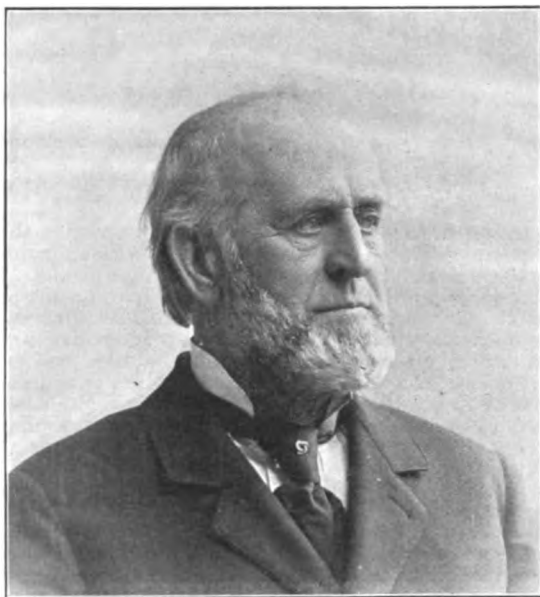
While the matter is by no means settled, the trend of scientific thought seems to favor some form of organic origin, while the organism from which the petroleum came may have been either animal or vegetable according to the conditions.

OBITUARY.

ABRAM H. VANDLING.

Abram H. Vandling, for many years superintendent of the Coal Department of the Delaware & Hudson Railroad Co., was found dead in his bed on the morning of June 12, death being due to heart disease, from which trouble he had been a great sufferer during the past two years.

Mr. Vandling was one of the earliest and best-known anthracite coal men, having been identified with the Delaware & Hudson and Pennsylvania Coal companies for many years. He was born in Mooresburg, Pa., November 13, 1824, and was the son of John S. Vandling. He received a thorough high-school



education, and for a while taught in Northumberland County, but soon became engaged in boat building at Lewisburg, Pa. After mastering the details of this trade, he accepted a position under the late John B. Smith, of the Pennsylvania Coal Co., and became superintendent of the yards at Hawley. Later he went to New York and was with General Ewen, of the same company, during the litigation which took place between the Delaware & Hudson and Pennsylvania Coal companies. Shortly after this he left the employ of the Pennsylvania Coal Co., and became superintendent of the Delaware & Hudson Canal at Rondout, N. Y. In 1874, he came to Scranton and became general superintendent of the coal properties of the Delaware & Hudson Co., filling that position until he was succeeded, 5 years ago, by his son-in-law, the present general superintendent, Mr. C. C. Rose. He was a director of the Third National Bank and of the Kingston Bank, and is survived by a wife and daughter.

GEORGE H. JOHNS.

George H. Johns, a pioneer in the Lehigh region of the anthracite coal field and a well-known coal operator in that section, died at his home in Hazleton, June 9, 1901. Mr. Johns contracted a cold in Constantinople while on a tour through Europe and the Far East, and he has never been well since his return from this trip over a year ago, since which time he has been unable to leave his home. During this time he has had a number of critical attacks, but a rugged constitution has enabled him to successfully combat these various attacks, though each one left him weaker. Mr. Johns was born in Wales, October 21, 1827, but when he was four years old his family came to the United States and located in Pottsville, where he acquired a common school education, but at an early age became interested in mining in the vicinity of Summit Hill. In 1851 he went to California, and being successful there, he was subsequently joined by his family. He remained in California until 1865, when he moved to Hazleton and there took up his residence. After a visit to Wales, to recuperate, he took a position at the Audenried colliery, owned by James B. McCreary & Co., and after several years he became associated with A. L. Mumper & Co., of Yorktown, which firm was later succeeded by that of Thomas Johns & Co. He became, in 1870, part owner and general superintendent of the Bear Ridge Coal Co., at Mahanoy Plane, where he remained for ten years and at the end of this time disposed of his interest and returned to Yorktown and associated himself with the firm of George H. Myers & Co. Mr. Johns took charge of the property as general manager. He remained a member of this firm until the colliery was absorbed by the Lehigh Valley Coal Co., a few years ago. Mr. Johns was a director of the Diamond Water Co., of Hazleton, the Opera House Co., and a member of Ashland Lodge, F. & A. M. Of late years he has been an extensive traveler and has made frequent trips to California and the South. His wife died several years ago but he is survived by five daughters and one son.

EVAN P. DAVIS.

Evan P. Davis, inside foreman at the Tripp slope and Diamond drift of the Delaware, Lackawanna & Western Co., died at his home, in Scranton, June 2, after a two weeks' illness, due to an abscess of the brain. Mr. Davis was born in Pen y Bont, Breconshire, South Wales, on December 19, 1851, and came to America with his uncle, William Jenkins, when he was ten years of age. He began mining at an early age, and attained the reputation of being one of the most expert in the anthracite coal regions. After engaging in ordinary mine work for a number of years, he joined the Delaware and Hudson surveying corps, and while in that capacity at the Warrior Run colliery, was severely burned by an explosion of gas. Upon recovering from the accident, he entered Wyoming Seminary for a term, and from there went to the Black Diamond colliery, at North Wilkes-Barre, as a fire boss. Shortly afterwards, Mr. Davis became assistant engineer of construction on the Buffalo division of the Lackawanna Railroad, and afterwards entered the service of the Genesee Valley Railroad in a similar capacity. His next engagement was in the soft-coal regions, in Elk County, and afterwards he reentered the Lackawanna Co.'s service as a surveyor. Then he became superintendent for the Susquehanna Coal Co., at Nanticoke, and from there he came to the Mt. Pleasant mines as foreman. He remained there several years, and then engaged as a superintendent with the New York & Scranton Coal Co., at Peckville. His last engagement was with the Lackawanna Co. at the Tripp Slope and Diamond drift, where he remained up to the time of his illness.

BENJAMIN THOMAS LACEY.

Benjamin Thomas Lacey, president of the firm of Parke & Lacey, San Francisco, Cal., died at his home in that city May 21, at the age of 55 years. The cause of his death was Bright's disease. Mr. Lacey was born in 1846, in Wexford, Ireland. From there his family moved to Liverpool, where he was educated and learned the machinist's trade. He came to the United States in 1867, and settled for a time in Fitchburg, Mass., where with Charles Burleigh he perfected the Burleigh rock drill and air compressor, and was in charge of those machines when they were installed in the Hoosac Tunnel and later when they were used in removing rock at Hellgate. He afterwards went to Europe and took charge of the drills at the Mt. Ceniz Tunnel and after 3½ years returned to the United States and installed the same machinery at the Sutro Tunnel. Here he became acquainted with Lyman C. Parke, which acquaintance resulted later in the formation of the firm of Parke & Lacey, well-known dealers in mining machinery and tools of all descriptions. The firm has prospered greatly and has branches in Australia, where it has been very successful in introducing American machinery into the mining camps of the Australian States. Mr. Lacey leaves a widow, two sons, and two daughters.

BY-PRODUCTS FROM CHARCOAL.

What They Are—The Products From Various Woods—How They Are Obtained and Marketed.

By Frank H. Mason, U. S. Consul General, Berlin, Germany.

In compliance with a request from a resident of Michigan a Department instruction was sent, November 20, 1900, to consular officers in Germany, Norway, and Sweden, asking for information relative to charcoal production and by-products. The answers follow.

GERMANY.

Coincident with the development of coke manufacture in Germany by the use of retort ovens which recover the ammonia, gas, tar and its valuable derivatives that are wasted by the primitive "beehive" oven process, has been the improvement in methods and apparatus for wood distillation, through which the production of charcoal has been raised from the archaic, wasteful, earth-kiln process that recovered only charcoal and tar, to an intelligent, scientific system, by which every valuable element in the wood is saved and added to the wealth-producing power of the forests. So far has this been carried, that special patented processes have been devised for using even sawdust and the rough outer bark of trees as material for the manufacture of charcoal and other products.

The apparatus for wood distillation, which will be briefly described in a later section of this report, includes cast and plate iron retorts of various types, as well as ovens of masonry, together with pipes, coils, tanks, and pans for condensation and rectification of the several distillates and utilization of the gases. Retorts are heated either by direct firing from beneath or by superheated steam introduced in coils. Retorts with direct heating by fuel or gas flame are most in use, and they are of two general classes—the horizontal and vertical.

THE PRODUCTS OF WOOD DISTILLATION

form four primary groups, which, with their principal derivatives, may be synopsized as follows:

1. Uncondensed gases, which may be burned as fuel or, after certain treatment, used for illuminating purposes.
2. Tar, from which are derived benzol, naphthalene, paraffin, rosin, and phenyl acid (creosote).
3. Pyroligneous acid (wood vinegar), from which are derived acetic acid, acetone, and methyl, or wood, alcohol.
4. Charcoal.

The quantities of these several products which can be obtained from the distillation of a certain quantity of wood vary considerably according to the species or kind of timber used, its dryness,

Wood, 100 Parts.	Total Distillates.	Tar.	Hydrated Wood Vinegar (rav.)	Pure Acetic Acid.	Charcoal (dry).	Uncondensed Gases.
Hornbeam (<i>Carpinus betulus</i>):						
Slow distillation.....	52.40	4.75	47.68	6.43	25.37	22.23
Fast distillation.....	48.52	5.55	42.97	5.23	20.47	31.01
Birch (<i>Betula alba</i>):						
Slow distillation.....	51.05	5.46	45.59	5.63	29.64	19.71
Fast distillation.....	42.98	3.24	39.74	4.43	21.46	35.56
Beech (<i>Fagus sylvatica</i>):						
Slow distillation.....	51.65	5.85	45.80	5.21	26.69	21.66
Fast distillation.....	44.35	4.90	39.45	3.86	21.90	33.75
Poplar (<i>Populus tremulas</i>):						
Slow distillation.....	47.44	6.90	40.54	5.10	25.47	27.09
Fast distillation.....	46.36	6.91	39.45	4.36	21.33	32.31
Oak (<i>Quercus robur</i>):						
Slow distillation.....	48.15	3.70	44.45	4.08	34.68	17.17
Fast distillation.....	45.24	3.20	42.04	3.44	27.73	27.03
Larch (<i>Larix decidua</i>):						
Slow distillation.....	51.61	9.30	42.31	2.69	26.74	21.65
Fast distillation.....	43.77	5.58	38.19	2.06	24.06	32.17
Spruce (<i>Picea crebra</i>):						
Slow distillation.....	46.92	5.93	40.99	2.30	34.30	18.78
Fast distillation.....	46.35	6.20	40.15	1.78	24.24	29.41

and especially the time consumed by the process of distillation, it being a general principle that, within reasonable limits, slow distillation yields larger percentages of distillates than are recovered when the process is quickened. All this has been reduced to exactly demonstrated results by the German chemists, and these have been tabulated by Professor Fisher in his Chemical Technology to show the comparative yield, by slow and quick distillation respectively, of the seven species of wood that are most employed for charcoal manufacture in Germany. The table shows for each kind of wood two lines of figures, the first of which (slow distillation) shows the products obtained when the wood was put into a cold retort and heated for a period of six hours; the second line (fast distillation) shows the results when similar

wood was put into a glowing retort and exposed to a fierce heat for a period of three hours.

These figures show the yield in pure, dry charcoal, which, on exposure to the air, absorbs moisture to an extent of from 4 to 10 per cent. of its weight, according to the kind of wood from which the charcoal was made. Of the above varieties, the English hornbeam is practically similar to the "blue beech" (*C. Americana*) of the United States; and the beech, birch, and spruce are so nearly identical with American woods of the same name that the foregoing table of distillates will be found substantially correct for the woods mostly employed for charcoal manufacture in our country. It will be seen that the charcoal yield is about one-fourth of the entire weight of wood, the total distillates one-half, and the greater portion of these is hydrated wood vinegar, which in its crude form contains about 12 per cent. of crystallized acetic acid.

NATURE AND USES OF THE SEVERAL DISTILLATES.

Taking up these several by-products in their order, the second in commercial importance is probably the wood tar, which is found more or less in all kinds of timber, but most plentifully in the larches and other conifers.

THE TAR PRODUCTS.

Wood tar is composed mainly of several hydrocarburets, the most important of which have been isolated as follows: Benzol (C_6H_6), toluol (C_7H_8), xymol (C_8H_{10}), cumol (C_9H_{12}), naphthalene ($C_{10}H_8$), and paraffin ($C_{20}H_{42}$), all of which are chemically neutral, besides the following acids: Phenlic acid (C_6H_5O), kresylphenol (C_8H_7O), and phenyl acid (C_6H_5O). Some of these have only a scientific interest and need not be separately discussed in a report of this character. The tar which contains them is expelled from the wood at temperatures exceeding 360° Celsius. The higher the temperature and the more rapid the process of distillation, the greater the percentage of tar and gas produced and the smaller the yield of acetic acid. The tar obtained as a by-product of charcoal manufacture from hard woods is mainly used for the production of creosote and applied to the antiseptic treatment of wood, such as posts, railway ties, paving blocks, etc., to protect the fiber against decay. When used as a raw material for producing any of the above-named hydrocarburets, that forms a separate chemical industry. The best known of them are:

Benzol, which boils at 82° Celsius and has a specific gravity of 0.85.

Toluol, which boils at 111° Celsius and has a specific gravity of 0.87.

Xymol, which boils at 139° Celsius and has a specific gravity of 0.875.

Cumol, which boils at 166° Celsius and has a specific gravity of 0.887.

Cymol, which boils at 175° Celsius and has a specific gravity of 0.85.

By reason of these sharply defined characteristics, they can be rather easily separated, and when treated with ammonia, produce bases, which, being oxidized, yield aniline colors. Industrially, however, anilines are mainly produced from the cheaper benzol and other derivatives from coal tar. The principal value of these elements when derived from wood tar is that they serve for a vast range of interesting researches for new and valuable shades of colors. Naphthalene and paraffin are the hydrocarbons which occur in small proportions in wood tar. Naphthalene is converted by treatment with nitric acid into nitronaphthalene, from which is obtained naphthylamin, an important material for the production of certain red and yellow aniline dyes.

The paraffin in wood tar is characterized by a remarkably high melting point—360° to 400° Celsius—and is of small industrial importance, for the reason that it can be obtained so much more abundantly and cheaply from coal tar. Of the oxidized, and therefore acid, combinations in wood tar, phlorol and kresylphenol have been isolated and have a certain scientific interest. Both these contain carboic acid (C_6H_7O), and all are usually left in the liquid creosote, which is used as an antiseptic for the impregnation of wood to prevent decay.

THE ACID PRODUCTS.

By far the most important by-product of wood distillation in charcoal manufacture is the pyroligneous acid, or wood vinegar, which in its raw state, as it comes from the still, is an impure hydrated solution ($C_2H_4O_2$), a colorless, inflammable liquid, with a sour, pungent smell and, as already stated, 12 per cent. of pure acetic acid. It boils at 117.3° Celsius and at 4° the acid solidifies in laminated crystals which fuse at 16° C. From the table already given, it will be seen that the yield of pure acetic acid is highest in the hard woods, viz., 6.43 per cent. in blue beech, 5.63 per cent. in birch, and 5.21 per cent. in white beech, whereas the larch yields only 2.69 per cent., and spruce 2.3 per cent. under slow distillation. Pure acetic acid is derived from raw wood vinegar by several processes, the simplest of which is as follows:

The raw distillate is first left standing for a certain time to permit the tarry elements which it contains to separate by settling. The clarified liquid is then put into a retort, with rectifying apparatus attached, and heated until the methyl alcohol and other light and volatile elements are expelled and pass over into a distillate, which is reduced by subsequent processes to alcohol and acetone, as will be elsewhere described in this report. The heating is continued until the areometer shows a specific gravity of 1.000, indicating that the lighter elements have been eliminated. The acid solution is then drawn off and neutralized with a base—usually lime or soda. This takes up the acid forming an acetate, which, on being decomposed, yields acetic acid. The cheapest base for this process is limestone, but it should be pure, or as nearly as possible free from organic impurities, which would, until eliminated, injure the quality of the acetate.

Acetic acid is sufficiently powerful to expel the carbonic acid in limestone, but the neutralization process causes thereby a strong effervescence, so that it must be accomplished in large, deep tanks in which the effervescing mixture will not boil over. If, instead of limestone, pure burnt lime is used, the effervescence is greatly reduced; but in either case it is important that the amount of basic material should not be in excess. In other words, it should be just sufficient to neutralize the acetic acid—which it does first—and not enough to take up afterwards the acid elements of the tar, which, being lighter than the acetate of lime, rise to the surface during the reaction and should be removed by skimming. The clarified solution is then evaporated in large shallow pans, yielding as a residuum crude acetate of lime. Overheating during the evaporation decomposes the acetate, so that a slow, steady, and uniform heat is necessary, and for this purpose the off-gases from the retorts in which the wood is distilled are used whenever practicable. The crude residuum is a gray, odorless mass, containing about 75 per cent. of pure calcium acetate, and forms a standard article of commerce. It is purified by dissolving in water, filtering the solution through bone black, and concentration by evaporation to a specific gravity of 1.16, when the salt crystallizes in small odorless needles, which are principally used as material for the production of acetone.

Acetate of lime appears in commerce in three grades of purity, the highest of which is now worth in large quantities 2.50 marks (60 cents) per kilogram (2.2046 pounds); the medium grade, 40 cents; and the lowest, 33 cents per kilogram. Its growing importance as a commercial product will be inferred from the fact that the exports of acetate of lime from Germany in 1898 were 8,529,300 kilograms; in 1899, 10,005,700 kilograms; and in 1900, 15,378,600 kilograms (33,295,000 pounds), of which last 1,382,140 pounds went to the United States.

When soda is used as the neutralizing base, the product is acetate of soda, and the process throughout is in general similar to that when lime is employed. The acetate of soda has various uses, but its crystals disintegrate when exposed to the air, and for this and other reasons it is less important in Germany than acetate of lime. Both are used as a means of extracting acetic acid from the raw wood vinegar, after which they are decomposed by various processes to obtain the crystallized acetic acid. When pure acid is to be obtained on a large scale, the soda acetate is preferred, as the acetic acid obtained from calcium acetate contains impurities which are difficult to eradicate. In either case, however, the acetate is decomposed by the action of a mineral acid, sufficiently powerful to displace the acetic acid from combination with the base, by which process the former is isolated.

Pure acetic acid is used for many purposes, among others making edible vinegar. When prepared for this use, it must be carefully cleansed from empyreumatic impurities, which give it a disagreeable, smoky flavor. This is accomplished by decomposing crystallized or freshly molten anhydrous acetate of soda by the admixture of 36 parts to 100 of sulphuric acid, which yields 80 parts of acetic acid of 54 to 55 per cent. purity, and this is further purified by dissolving in water, distilling, and rectification. The process leaves as a residuum bisulphate of soda, which it requires a complicated process to utilize, and the distillation has to be performed in glazed or silver-lined retorts and cooling tubes in order to prevent the acetic acid from becoming contaminated with iron or copper. The resulting product, known in commerce as "essence of vinegar," can be made into table vinegar by dissolving in twenty times its volume of water. Of the

DIRECT DERIVATIVES FROM THE ACETIC ACID

the most important is acetone (C_3H_6O), a colorless liquid which is used as a solvent in aniline and several other branches of chemical manufacture, especially in the production of smokeless powder and other explosives. Acetone is obtained by separating acetic acid into three simple compounds—acetone, carbonic acid, and water. For this purpose the acetic acid is neutralized with lime, and the acetate thus formed is heated in a retort with a stem leading to a coil condenser. On account of the low boiling point

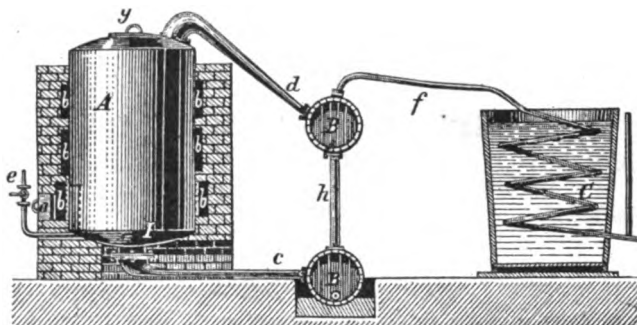
of acetone ($56^\circ C.$), this coil must be kept at a very low temperature to produce complete condensation. In the industrial process, the acetate of lime is dried, finely pulverized, and then put into the retort, where it is heated until the acetone has all passed over, when the residuum is withdrawn and again used for making fresh acetate of lime, with which the operation is repeated. Acetone of 56° to 58° purity is now worth about 50 cents per kilogram (2.2046 pounds), and, like acetate of lime, is a standard commercial product. It may be further decomposed and yields metacetone ($C_6H_{10}O$), a fragrant aromatic liquid which boils at $84^\circ C.$ and is used as a solvent for essential oils in the manufacture of perfumes.

The next valuable derivative from acetic acid is wood spirit or methyl alcohol (CH_3O), called in German "Holzgeist," a colorless, volatile, and inflammable liquid which boils at $66.3^\circ C.$ and has a specific gravity of 0.800. It burns with a bluish flame of low illuminating power, dissolves resins, gums, and essential oils, and is extensively used in the manufacture of lacs and varnishes and for the denaturalization of spirits which are to be used for industrial purposes. The exports of wood alcohol from Germany in 1899 amounted to 6,703,620 pounds, valued at \$662,354.

Among the other useful products of wood distillation is oxalic acid, an important substance in dyeing and cloth printing, which was formerly prepared by oxidizing sugar, but is now much more cheaply obtained from sawdust by the action of alkalies.

APPARATUS FOR WOOD DISTILLATION.

Since the commencement of wood distillation as a practical industry nearly fifty years ago, many changes and improvements have been made in the machinery employed, which for economical practice requires to be adapted to the kinds of wood to be worked, the quantity to be treated at each operation, and to which of the distillates, tar or acid, is regarded of first importance. Wood is a bad conductor of heat, so that in the construction of all retorts, the problem is to secure as prompt and thorough a



APPARATUS FOR WOOD DISTILLATION.

distribution of heat as possible throughout the mass, combined with such dimensions as will render the charging of the retort with wood and the withdrawal of the charcoal reasonably convenient. All plants for wood distillation combine substantially the features which are shown in the accompanying sketch, which is a simple, upright retort, with a capacity of 8 cubic meters (about $2\frac{1}{2}$ cords) of wood.

In this figure, the retort A is made of ordinary or galvanized boiler plate, set in brick masonry, surrounded by a spiral flue b, so that the fire introduced at the furnace a is drawn by the chimney draft round and round the outer shell of the retort, which is filled with wood and the charcoal discharged through the manhole y. To quicken the heating of the charge to $100^\circ C.$ —at which temperature the development of gases begins—superheated steam is turned in through the pipe e. The crude inflammable gases which are first generated are discharged downward into the fire through a pipe not shown in the drawing. As the heat increases, the steam and gas pipes are closed and the distillates begin to pass over. The tar flows downward through the pipe c, the acid gases pass upward through the beak d into the drum B, where the tarry vapors condense and are carried downward to the tar tank (lower B), which is kept cool by partial immersion in water. The pyroligneous acid gas, nearly freed from tarry impurities, passes on through f and the cold coil C, where it is condensed and pours out in the form of raw wood vinegar. These are the rudiments of the process.

In anticipation that the European process of making charcoal with recovery of the tar and acid products might have a practical interest for charcoal manufacturers in the United States, an engineer familiar with this industry has been consulted, and he has obtained from several German manufacturers of apparatus and fixtures for these purposes estimates of the cost of equipment for a plant of the standard capacity, viz., 75 cubic meters (2,649 cubic feet) of wood per day. In practice, it has been found most

economical to set up the distillation plant as near as possible to where the wood is cut; in other words, at the point where all conditions of transportation for raw material and products are most favorable. The ordinary practice involves the distillation of hard woods—beech or oak—and the recovery of charcoal, tar, raw wood vinegar, and methyl alcohol. The charcoal, or first product, is ready for market on being withdrawn from the retort. The tar is sent as raw material to chemical factories, where it is worked up as a separate industry. The methyl alcohol is also a commercial product and is usually sold in its crude state; but the wood vinegar is usually consumed on the spot for the production of acetate of lime, which, as already explained, is a convenient vehicle for recovering and transporting the pure acetic acid contained in the wood vinegar, which for this purpose is treated with ordinary limestone. Assuming, therefore, that a firm or company in the United States should wish to establish a modern German plant of this kind, and for that purpose to obtain the necessary machinery in Germany, the calculation would be somewhat as follows:

Distilling apparatus complete, without buildings, for treating 75 cubic meters (22½ cords) of wood per day, would cost here 105,000 marks (\$24,990). If the capacity were increased to 100 cubic meters (30 cords) per day, the cost of plant would be about 130,000 marks (\$30,940). If greater capacity is desired, it would be advisable to duplicate the same apparatus, instead of further increasing the size of the unit.

If beech wood is used, the raw vinegar obtained will be from 40 to 45 per cent. of the weight of wood, and the vinegar should yield from 9 to 12 per cent. of pure acetic acid. Assuming that this is to be recovered on the spot, a plant for the daily production of 1,200 kilograms (2,640 pounds) of acetate of lime would cost, exclusive of buildings, about 15,000 marks (\$3,570). This assumes that the raw pyroligneous acid is to be treated with ordinary limestone, a process which involves no technical difficulties. So far as can be ascertained, the apparatus for the industry involves few or no essential features which are covered by patents, so that a modern scientific plant, once established and its success demonstrated, could be duplicated to any extent which supply of material and the market for its products might require.

LEGAL DECISIONS ON MINING QUESTIONS.

Assignee of Lessor Not Compelled to Buy Improvements.

—A provision in a mining lease that at the expiration of the same the lessor will take the improvements, paying a fair cash valuation for them, is not binding on his assignee.—*Etowah Min. Co. v. Wills Val. Min. & Mfg. Co.*, 25 Southern Reporter, 720. (Supreme Court of Ala.)

Right to Appropriate Water.—Where a third party, who owned land on which there was a placer mine, used water from a certain ditch to operate the mine as long as the land remained in his possession, such use made the right to appropriate water appurtenant to the land, and it passed with the land under a deed thereof.—*Mattis vs. Hosmer et al.*, 62 Pac. Rep. (Or.) 17.

Rights of Joint Owners.—Complainant and defendants were joint owners of a group of mining claims, and defendants were owners of an adjoining claim. A tunnel had been run through the group owned jointly, for the purpose of working that property; and defendants extended the tunnel into the property owned by them, and the use of the tunnel by defendants in working their property resulted in the exclusion of complainant from the tunnel. Held, that complainant was entitled to an injunction restraining defendants from excluding her from the tunnel.—*People ex rel. Brene et al. vs. District Court of Lake County et al.*, 62 Pac. Rep. (Colo.) 206.

Duty to Ventilate Under Laws of United States.—The duty of a mine owner as to ventilation of his mine and keeping it clear of standing gas is made imperative by the act of Congress of March 3rd, 1891, and the consequence of neglecting it cannot be excused because some workmen may disregard instructions. Instructions as to duty of a mine owner with respect to ventilating a mine, etc. are erroneous when they are so inconsistent with other instructions that they tend to confusion, and when they make his duty relative instead of absolute. The place of explosion in a mine and its cause, and what if any negligence the owner is guilty of are for the jury, when the evidence offered requires their submission to the jury.—*Deerent v. Cerillos Coal R. Co.* (20 U. S. Supreme Court Reports, 967) United States Supreme Court.

Benefit of Work Performed.—Plaintiff located a mining claim, and thereafter defendant entered on the land, claiming it as vacant mineral land, in that plaintiff had failed to do the amount of work required by law for five years previous. Plaintiffs owned a claim that overlapped the claim in dispute, and on the land common to both claims had done work in the way of tunneling largely in excess of that required by law, with the manifest intention of

striking the lode of the claim in dispute. Held, that a finding that the work performed could not be a benefit to the claim in dispute, and that plaintiffs were not entitled to the same, was erroneous, since the court could not be permitted to substitute its judgment as to the expediency of the methods employed for developing a mine for that of the owners.—*Mann vs. Budlong, et al.*, 62 Pac. Rep. (Cal.) 120.

Suits by Minority Stockholders in Mining Company.—Minority stockholders cannot maintain a suit against the majority to enjoin a proposed sale of its property, on the theory that it is the suit of the corporation itself, brought in their name, because of the refusal or neglect of the directors to bring it in the name of the corporation, where the majority are not acting in bad faith, or have not combined to take action to the injury of the minority; nor can such minority stockholders, as such, maintain such a suit on the ground of injury to stock, since the threatened damage is not personal or peculiar to the minority. The burden is on the minority to show bad faith or a combination on the part of the majority to assume control to the injury of the minority.—*Lewison v. Anaconda Copper Mining Co.*, 56 New York Supplement Reporter, 807. (Supreme Court of N. Y.)

Construction of Coal Lease.—A party leased of another all the coal contained in or under certain lands, and was to pay for coal mined and taken out, at a certain royalty per ton, on clean merchantable coal, "exclusive of culm or mine waste which would pass through a one-half inch mesh" and that he should pay for 10,000 tons yearly, whether that amount was taken out or not, and interest on sums representing yearly deficiencies below 20,000 tons until that amount was reached. The court held that the provision regarding culm was to be constructed as permitting the lessee to mine culm, or not, as he chooses, but that if he did mine and appropriate culm, he was liable for royalties on same.—*Genet v. President Delaware & H. Canal Co.* (57 Northeastern Reporter, 297), Court of Appeals of New York.

Natural Gas Not Subject to Public Appropriation.—Since the right to mine natural gas, when left to the natural laws of flowage, exists exclusively in the owners of the superincumbent lands, and such gas is not subject to public appropriation without their consent, they are entitled to preserve it from destruction, independent of the right of the state to regulate it, and may enjoin any act of any one owner to induce an unnatural flow into or through his wells which tends to the injury or destruction of the common supply. Such gas does not become the property of any one until reduced into actual possessions; hence objections based on the right of transportation and sale are not pertinent to a complaint to enjoin the use of artificial means to increase the flow.—*Manufacturers' Gas & Oil Co. v. Indiana Nat. Gas & Oil Co.* (57 Northeastern Reporter, 9-912) Supreme Court of Indiana.

Question of Negligence for the Jury.—Plaintiff's husband was killed, with other workmen, by the breaking and falling of a stull in defendant's mine, on which he was working in stoping ore 70 feet from the bottom. The stull was erected by defendant by placing lagging on timbers running across a fissure in which it was built, and supported in its sides, and was intended to be of sufficient strength to sustain the weight of 20 feet of earth and rock upon its top, although there was but 9 feet in depth upon it when it broke and fell. Held, that the fact of its falling under such circumstances was in itself evidence from which a jury might infer that it had not been properly constructed, and that, when taken in connection with the fact that a number of the cross-timbers were broken in the middle, and with the testimony of two competent witnesses, who stated their opinions that the timbers were insufficient in strength to carry the load placed upon them, it could not be held, as matter of law, that defendant was not negligent, but the question was one for the jury.—*Westland v. Gold Coin Mines Co.*, 101 Fed. Rep. (U. S.) 59.

Polluting a Stream with Tailings.—In making preparations to start up a mill for the reduction of gold and silver ores, which had been idle for a number of years, plaintiff found the water at a settling tank, from which the supply of water for operating the mill was obtained, contained a quantity of tailings, and that after being cleaned out the tailings and debris from above came into the tank in such quantities as might, if continued, prevent the mill from being run. Thereupon plaintiff demanded of defendant, who was operating a mill above the plaintiff's on the same creek, that he prevent his tailings from polluting the water, and was given assurance that by the time he got ready to start up this would be done. At the time this suit was commenced defendant was not discharging tailings or sediment into the stream sufficiently to interfere with plaintiff's using its waters for his mill, and had constructed a series of reservoirs by which he impounded the tailings, and prevented any injurious matter flowing from his mill into the creek. Held, that plaintiff was not entitled to an injunction restraining defendant from polluting the stream.—*Otaheite Gold & Silver Min. & Mill Co. vs. Dean* 102 Fed. Rep. (U. S.) 929.

LIGNITE DEPOSITS,

Or Fields of Brown Coal in North Dakota—Their Extent, Thickness and Fuel Value.

Written for MINES AND MINERALS, by R. M. Haseltine.*

During the past summer I was called upon by Senator W. D. Washburn, of Minneapolis, to make a report upon the lignite deposits in North Dakota.

In making this investigation of the lignite, or brown coal deposits of the northwest, I was at once impressed with the lack of attention it has received by the scientists or people who are interested in the mineral resources of the country. Geologists, beyond a brief mention of its existing in various portions of the country lying west of the Mississippi River, have evidently given its area and value but little thought. Hence it is that its adaptability for man's use has received little or no consideration, thus preventing the making of comparisons of the value of lignite originating in different countries, or in different fields in the same country. This is no doubt due, in a great measure, to the large amount of excellent coal that has always been available in the more populous portion of the country, and the further fact that where lignite deposits of the greatest value exist the country is sparsely settled, and the limited supply of wood has thus far practically met all of the requirements.

This appears to have been especially true in North Dakota—a State which can be briefly described as one vast, treeless prairie. In the eastern portion of the State, while apparently no more fertile, it is more densely populated than the central and western portions; this is no doubt mainly due to the presence of timber along the streams; also to the possibility of securing bituminous coal from the mines in the Eastern States in sufficient quantities and at a reasonable cost.

Throughout this portion of our commonwealth the Northern Pacific Railroad Co. owns each alternate section of land for forty miles on each side of its track. To the inhabitants from the vicinity of Jamestown to the western line of the State—located as they are from 350 to 600 miles from Duluth, the nearest port on the Great Lakes—the question of fuel presents a serious proposition. Similar conditions no doubt exist along the other transcontinental lines, but as they were not examined this paper will be confined to the territory adjacent to this great thoroughfare.

Throughout the length of the Northern Pacific Railroad, in North Dakota, the conditions appear to be adverse to the growth of timber; many places were noticed where groves had been planted under the act passed by Congress, whereby it was provided that 160 acres of land were to be granted to any settler who would plant 80 acres in timber. In a few instances, where the trees have been regularly cultivated, the groves appear to be fairly thrifty, and in a few instances the trees have attained a size suitable for mine props; but wherever they were neglected and the grass was allowed to grow around the trunk of the tree, they soon began to show signs of decay; in a number of instances what had apparently been a promising grove had decayed until it was nothing more than a pigeon roost. It is evident that the rainfall along this belt of country is insufficient for the growth of large timber, and that the continuous blowing of the wind whips the young trees to death. The only appearance of native timber is close along the streams where the soil is continually moist. On the Missouri River, at Bismarck, and for miles above and below, the meager growth of timber along its banks has been cut down for fuel until there is scarcely a tree from which a sawlog could be secured. It is evident that the necessities of the people for both wood and shade are such that, were the growth of timber possible, its cultivation would not have been neglected. It will be seen that not only at the present time but in the future any article of fuel will be of great value, and that as the country settles up the value of fuel will increase in a like ratio.

As to the origin of lignite, like bituminous coal, the authorities differ; the generally accepted theory, however, appears to be that it is the product of immense drifts of timber that during the Cretaceous age or early Tertiary period, were floating on the great inland sea which then covered the western part of the country extending from the Rocky Mountains eastward to and beyond the Mississippi River. These drifts were carried into eddies or pools of tranquil water, where it settled and was submerged by the clays and sands under which it was compressed.

Paton says, that during the Cretaceous and early Tertiary periods an immense swamp seems to have existed along the eastern foot of the Rocky Mountains, extending from New Mexico on the south, to many hundreds of miles into the British possessions on the north. F. V. Hayden, U. S. Geologist, in one of his reports says that along the Missouri River, as well as along the Yellowstone River, there are numerous beds of Tertiary

lignite, ranging from a few inches to seven feet in thickness. The United States Government in 1884 organized an expedition under Prof. Bailey Willis, to make a report upon the lignite beds in the great Sioux Reservation, now a part of South Dakota. The party started from Mandan, a station on the Northern Pacific R. R., on the south side of the Missouri River and six miles west of Bismarck, North Dakota. They pursued a south-westerly course to the reservation. The expedition reported the discovery of several thousand square miles of lignite, but gave it as their opinion that but little if any was of a workable thickness. Had this party directed their explorations in either a northeasterly, northerly, or northwesterly direction, they would have traversed large fields of rich lignite, from 8 to 15 feet in thickness, and their labors would have enabled them to have made a more hopeful report.

It being true that lignite is the product of drifting timber, there is no doubt but McFarland in his remarks about the lignite beds of Great Britain, is correct when he says that it is liable to be composed of nothing more than dead wood and dry mud, and under such circumstances it has no value whatever as a fuel. The same authority also says that the lignite deposits lying along the Northern Pacific Railroad in some instances carry bands of carbon which resembles Spanish licorice, and are superior in quality to those found in any other part of the world. As to its composition, Geike says that lignite may be regarded as a stage in the alteration and mineralization of vegetable matter, intermediate between peat and true coal. In other words, it is chemically altered vegetable matter, often retaining lamellar or ligneous texture with seams showing woody fiber which crosses in all direction.

The United States Geological Survey in 1900, reports the presence of lignite in six counties in North Dakota, viz.: Ward with 7 mines, Stark with 2, Morton with 4, Emmons with 2, McLean with 5, and Burleigh with 5; a total of 25. The writer examined 33% of them; It is not slander, certainly not a sacrilege, to say that it required a highly cultivated and sensitive imagination to dignify them with the title of a mine.

From all of the information at hand it is evident that there are no large deposits of lignite in the eastern portion of the State; at least none of sufficient importance to attract attention. The first large deposit, on the line of the Northern Pacific Railroad, occurs on a line running almost due north and south from Bismarck. From this point westward, thick deposits are said to occur at intervals, extending to the foot of the Rocky Mountains. The first deposit examined by the writer was in McLean County, at a point two miles north from the Missouri River, and five miles in a northwesterly direction from Washburn, the county seat. The opening was a drift made into the south side of a valley (here called a "coulee"), which runs from the highlands to the river. This deposit was first opened during 1893. The entry, after being driven in a short distance, was permitted to fall in. This method of procedure had evidently been repeated several times.

The present entry has advanced about 150 feet. At the face, the lignite, capped with two feet of white fireclay, appears in two benches; the upper bench was four feet ten inches in thickness. It appeared in layers, varying from one to four inches in thickness. This rested upon a stratum of white fireclay, from one inch to one and one-half inches in thickness. Under this band there is about five feet of lignite, deposited in small irregular blocks of various thicknesses, but without any regular facings or slips. Of this entire vein but seven feet are recovered; from one to one and one-half feet are left up to sustain the roof; the balance remains submerged in the floor of the mine, for want of proper draining. A break near the bluff exposed a columnar section, beginning at the top of the lignite, over which there were seen two feet of fireclay, then came a deposit of ten or twelve feet of white sand, so firmly compressed as to resemble sandstone, but possessing no strength whatever; over this there was a deposit of gravel; on the top of which came the soil.

The product of this mine up to this time has been sold in Washburn, for steam and domestic purposes. Three samples were secured; one from the bench lying above the fireclay band, and one from below and lying above the water line; the third was taken from a pile of lignite that had been exposed to the weather during the summer, and had disintegrated until the particles ranged in size from that of a silver dollar down to that of a ten-cent piece. An analysis of these samples exhibited the following composition:

	Exposed Sample.	Top Sample 4 Ft. 10 In.	Lower Bench.
Water	16.30	26.25	24.25
Vol. Comb.	33.70	36.25	26.55
Fixed carbon	40.00	31.40	25.45
Ash	9.10	6.10	21.70
Sulphur	0.61	0.79	1.16

* A paper read before the Ohio Institute of Mining Engineers, Feb. 28, 1901.

It will be observed that the exposed sample retained all of its economic value, the only loss being in the moisture. It is also evident that the lower bench is inferior to the top stratum and contains three times the volume of ash. The second examination was made in a valley running in an easterly and westerly direction, at a point about ten miles northeasterly from the above described mine. Here the lignite has been secured by stripping off the surface. The appearances indicated that its existence had been known for a long time, as the area over which it had been removed exceeded over two acres. The stripping now had attained a thickness of about twenty feet. Here the top branch was four feet eight inches in thickness, and separated from the lower branch, which is said to be five feet in thickness, by a band of clay one inch thick. It will be observed that the formations here are strikingly similar to those existing at the first point mentioned, but owing to the character of lignite deposits and the absence of any intermediate drilling, while it is possible, there is no certainty that the vein exists throughout the intermediate field. An analysis of this coal shows that it contains:

Water	26.15
Vol. Comb.	36.25
Fixed carbon	31.10
Ash	6.50
Sulphur	0.51

The third point visited was the Eckland mine, about three miles southeast of Wilton, the present terminus of the Bismarck, Washburn, and Great Falls R. R., and about thirty miles north of Bismarck. Here the lignite is reached by means of a slope about 150 feet in length, from the bottom of which the main entry has advanced in a southeasterly direction about 100 feet. The lignite here is about 11 feet in thickness without a parting, 8 feet of which is being mined. The deposit here seems to be hard and firm, and from the accompanying analysis it would be seen to be the equal of any deposit examined.

Water	29.65
Vol. Comb.	31.95
Fixed carbon	33.00
Ash	5.20
Sulphur	0.54

The next examination was of the little Casino mine, located some five or six miles southwest of Wilton. The lignite here was first mined in the year 1887; this was done by first removing the surface, then quarrying the mineral. In this manner, from 6 to 7 feet of the deposit extending over several acres were recovered and used for domestic purposes by the early settlers. For several years the mining has been conducted by means of a drift. The main entry, seven feet in width, has been driven single and runs in an easterly direction. The rooms are worked 16 feet in width, and are driven both north and south. Ribs 10 feet in width are left between the rooms for their support. From 1 to 1½ feet are left up to support the roof, and from 3 to 4 feet of the bottom are permitted to remain unmined owing to a want of proper drainage. A sample taken from an entry rib well into the mine, shows the lignite to contain:

Water	29.65
Vol. Comb.	32.65
Fixed carbon	27.10
Ash	10.35
Sulphur	1.25

The mine is owned by Miss Elizabeth McClellan, a pioneer settler in this section of the country, who superintends the mine in person; and her management and general knowledge of mining compares favorably with that of her male competitors.

The next mines examined were at Sims, a station on the Northern Pacific Railway, 40 miles west of Bismarck. At the first mine visited, the lignite was reached by means of a slope. The main entry had been driven about 700 feet in a westerly direction. In mining, the rooms were driven from 18 to 20 feet in width, with about 10 feet of a pillar between them. The vein here is 6 feet in thickness, about 5 of which are removed. In pick mining from seven to eight tons is recognized as a day's work. A compressed air plant had been recently installed, and a Harrison shearing machine installed; it was working under about 40 pounds pressure. In driving the entry a shearing was made from 6 to 8 feet in depth. This was as near the center as possible, and the lignite was then shot from the ribs. This method of mining resulted in a fairly good appearing entry.

In room mining the method was to cut a channel in the center of the room; this was advanced from 7 to 8 feet in depth and 5 feet in height. The sides were then shot down, after which the roof and corners were trimmed with a pick. An analysis of the product of this mine exhibited:

Moisture	25.45
Vol. Comb.	37.20
Fixed carbon	30.65
Ash	6.30

A mine 1½ miles west of Sims was opened on the double entry system, a pillar of 15 feet being left for support. The entries were driven from 5 to 6 feet in width. The rooms were turned with

9-foot necks, and were widened out to 18 feet, with a pillar between them 12 feet in thickness. Their usual length was 150 feet. The lignite here was 8 feet in thickness, with a clay vein of two inches in thickness near the center. Six feet of this were removed in mining. Three tons from an entry and six from a room are regarded as a fair day's work. From an analysis of this deposit, it was learned that it contains:

Moisture	15.00
Vol. Comb.	38.90
Fixed carbon	31.00
Ash	15.10

At a point near Dickinson, 100 miles west of Bismarck, there is a mine which has been extensively operated for a number of years. The entries were driven single, with a minimum width of 14 feet. The rooms were broken away with 10-foot necks, when they were widened to 20 feet. These are driven in various lengths and are supported by ribs from 5 to 6 feet in width. The lignite here is from 8 to 15 feet in thickness, from 2 to 3 feet of which is left up to support the roof, which in both rooms and entries is arched, no posts being used. The mining is conducted on a system known as "mining on the solid." It is said that by this method one keg of powder will produce forty tons of lignite. This method of procedure leaves the ribs and roof irregular, and gives the mine a ragged and unsightly appearance. When the rooms have been driven to their limit, as large a portion of the ribs as can be secured without resorting to the use of timber is removed. It is said that at this work one keg of powder will produce one hundred tons of lignite. The indications are that fully one-third of this valuable fuel is allowed to remain unmined. The owners of this mine have an extensive trade, the product being shipped long distances, where it is used for both domestic and steam trade. From an analysis it is learned that it contains:

Moisture	12.70
Vol. Comb.	45.50
Fixed carbon	37.65
Ash	4.15

At all points visited, the deposit of lignite was found to be overlaid with a vein of fireclay of remarkable uniformity of thickness; thus necessitating the separation of the vein in order that a portion may be left up to support the roof.

From the U. S. Geological Survey, it is learned that the product of lignite in North Dakota since 1886 was:

1886	25,955	1891	30,000	1896	78,050
1887	21,470	1892	40,725	1897	77,246
1888	34,000	1893	49,630	1898	83,895
1889	41,431	1894	42,515	1899	98,809
1890	30,000	1895	39,197		

It will be seen that during the past decade the production has increased 58%.

Senator Washburn, of Minneapolis, Minnesota, who owns a large tract of land in Burleigh and McLean counties, in what is known as the Great Bend country, through which he is building the Bismarck, Washburn, and Great Falls Railway, has drilled up a tract embracing about 300 acres near Wilton, 30 miles north of Bismarck, the present terminus of his line. Out of about 30 drill holes, lignite from 9 to 12 feet in thickness was found in all but two or three. This tract of land lies within about two miles of the Eckland mine, and this body of lignite is no doubt a part of the same field. The deposit lies at a depth of from 50 to 70 feet below the surface, and the field contains about three million tons of this fuel. Since my examination of this property it has been opened, and at this writing the mine, the largest in the State, is producing from 200 to 300 tons per day. The analysis of a sample shows it to contain:

Moisture	18.05
Vol. Comb.	40.40
Fixed carbon	36.65
Ash	5.00
Sulphur	0.62

All of the above analyses were made by Prof. N. W. Lord, of the Ohio State University. In order that a comparison may be made with his work and that of other chemists, I give a copy of one made by Prof. Johnson of Yale College, from a sample of lignite taken from McLean County some years ago, which resulted:

Moisture	14.88
Vol. Comb.	36.72
Fixed carbon	44.31
Ash	3.44
Sulphur	0.45

In the United States Geological reports, Regis Chevenet and brother, of St. Louis, Mo., report a sample from the same county as containing:

Water and Vol. Comb.	47.27
Fixed carbon	45.77
Ash	6.96
Sulphur	0.22

Dr. C. Lenegeles, of Athens, in an article upon the lignite

veins of Greece, gives three analyses, evidently from samples taken at widely different points.

	Kumi.	Oropor.	Allokrior.
Carbon	44.64	38.99	40.24
Hydrogen	5.17	4.03	3.32
N.	1.64	2.51	0.97
S.	2.44	1.21	0.64
Ash	20.09	19.44	7.59
Moisture	14.09	13.72	14.69
Calorific value	5,076	4,764	4,994

The calorific power of the sample taken from the Eckland mine as determined at the Ohio State University was found to be 7,662 British thermal units; this is on the coal received, which contains 29.85% water. This will dry out easily, as an exposure of half an hour to a temperature considerably below that of boiling water causing the lignite to lose 21% of its moisture. It was the opinion of Prof. Lord that the calorific power of this lignite if dried down to 10% water, would be increased to 9,570 B. T. U. For comparison with well known bituminous coal, it is found that the average calorific value of the Pocahontas, West Virginia, coal is 14,590 B. T. U. The average of Hocking Valley, Ohio, coal is 12,000 B. T. U. That of the Pittsburg vein is 13,550. This will indicate the evaporating power of this North Dakota lignite when in its natural condition (wet), for steam raising purposes is approximately 52% of that of Pocahontas coal, and 60% of that of Hocking Valley coal, and 56% of Pittsburg coal. If dried down to 10% of water, it would run about 59%, 80% and 71% respectively.

Dr. Kosmann, in an article appearing in the Colliery Guardian of April, 1896, speaking of the European lignites, avers that fresh lignite contains an average of 50% water. Of this, 20% is regarded as chemically combined, and 30% is of a mechanical mixture. Any excess of water contained in lignite is a serious detriment to it in the market, as the consumer pays to the operator and the transportation company the same for it that he does for the mineral. Hence it is that as the water is removed the more valuable the lignite becomes as a fuel.

The analyses of lignite made in both this and European countries, show that it possesses units of heat which, when properly burned, will give to it great commercial value. This is especially true of the lignites of North Dakota, particularly in the counties above named, where it is demonstrated they are vastly superior in quality to any others of which we have a knowledge. It is believed that, with properly designed fireboxes, suitable grates, and a well regulated draft, and when this lignite is properly prepared to withstand the weather and resist the abuse encountered in being shipped long distances, it will meet with all of the requirements necessary to supply a fuel for this portion of our commonwealth.

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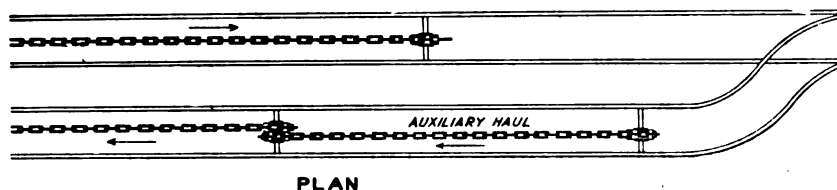
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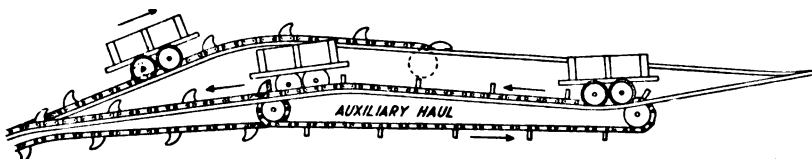
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PLAN



SIDE VIEW

SIDE VIEW AND PLAN OF CAR HAUL.

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PETROLEUM.

PETROLEUM or "Rock Oil" is now one of the best known of Nature's products, although it was practically unknown until the latter half of the 19th century. It has in this comparatively short time been found widely distributed over the earth's surface and it is now known to be one of the most widely distributed of our many useful mineral products.

Until very recently the principal fields in the United States were Pennsylvania, Ohio, New York, West Virginia, and Indiana, which formed what was commonly known as the "oil country." Now, however, petroleum is produced extensively in California, Colorado, Wyoming, and Texas, and this latter State bids fair to become the world's most wonderful producer. At Bothwell, Ontario, Canada, it has also been found in large quantities.

The principal foreign producers of petroleum are Russia, Borneo, and Japan, although it has been found in a large number of other localities, particularly in Germany and Scotland, where it occurs in formations similar to those in which it has been found in America. In South America it has been found in Peru and Brazil.

A detailed account of the occurrence of petroleum in California was contained in MINES AND MINERALS for May, and an account of its occurrence in Colorado in the June issue, while other accounts of its occurrence will follow in succeeding numbers. For the present therefore, we will content ourselves with taking a somewhat general view of the subject in connection with the older oil fields, leaving the details of its local occurrence in newer localities to subsequent articles.

In New York, Pennsylvania, and West Virginia, petroleum is found in sandstones of various geological formations. In the neighborhood of Titusville, Pennsylvania, oil springs are found, but the measures containing the oil dip gradually to the south-west from this locality, until they reach a depth of 3,400 to 4,000 feet in West Virginia. These so-called oil springs are not the out-crops of the sandstone, but they are simply locations where the oil has been forced to the surface by hydrostatic pressure. There are several distinct beds of this sandstone known as No. 1, No. 2, No. 3, etc., Oil Sand, numbering from the top downward, so that wells in the same section do not necessarily draw their supply from the same horizon.

The oil horizons in the more northerly counties of Pennsylvania and Southern New York are of an earlier geological formation and are found at a much greater depth, ranging from 1,100 to 1,700 feet. In Ohio and Indiana oil is obtained from the Trenton Limestone and the Berea Grit. The Canadian oil comes from the Carboniferous limestone, which lies close to the surface, so that the wells are shallow.

The presence of oil in Western Pennsylvania has been known for a long time, and one of the first accounts of it is contained in a report of a French Officer to General Montcalm in 1750. Although its presence was known thus early no use was made of it, and, as stated above, prior to 1850 little or nothing was done towards exploiting it or towards developing the petroleum industry. For many years it was gathered from the surface of the water and sold as Seneca Oil, being considered a most valuable cure for rheumatism, burns, and sprains. The name Seneca Oil was derived from the Seneca Indians, who inhabited Western Pennsylvania and New York, and who were using the oil as a medicine when the country was settled by the whites.

In addition to the little which was secured from the surface of wells, springs, etc., an additional supply was obtained from a number of salt wells, and these salt wells were in a number of instances the medium by which a hitherto unknown petroleum deposit was opened up.

No more interesting history has been written than an account of the development of the oil wells of Western Pennsylvania, and the oil excitement which started about fifty years ago paralleled in intensity the rush for gold to California in 1848, or the more recent Klondike craze. Cities grew up by magic and became

populous places for a few years, only to be depopulated as rapidly, and now, where formerly existed thriving centers of industry, nothing remains but a few ruins to tell of the former prosperity.

Attention was directed to Oil Creek by a favorable report dated April 16th, 1855, made by Prof. B. Silliman, of Yale College. In this same year three distinct attempts were made to secure petroleum, J. M. Williams excavating in Canada with pick and shovel to the oil sand, and T. W. Nevin & Co., at Greensburg, Pa., drilling 400 feet in depth. These two attempts failed and these failures permitted Colonel Drake to become the oil pioneer in America, and in March 1858 he started operations on Oil Creek. The oil craze soon took possession of a large number of people, and wells were started in great numbers, so that by 1861 the daily production had reached 7,000 barrels. The industry was not ready for such a development and the price fell to 20, 15, and finally to 10 cents per barrel. The quantity of oil was so great that it could not be stored, and large quantities were allowed to waste. Many operators were disheartened by these conditions and the industry took a slump for a short time, so that in May, 1865, the daily production was only 3,000 bbls. This congested condition, however, was soon overcome by increased transportation facilities, and the increase in the petroleum industry has since then been steady. Some of the old fields have to be sure been exhausted, but their places have been more than taken by new developments, and although many have predicted the disappearance of the petroleum industry, the developments of the past year show that this decline will probably be a long way in the future, if it ever comes.

The recent discoveries of petroleum in Texas and in a number of the other Western and Southwestern States have interjected a new element into the fuel problem. If these deposits of petroleum fulfill the prophecies now made for them as to their extent, a formidable competitor will have been found for our other fuel supplies, particularly if, as has been reported, the Texas oil is a distinctly fuel oil.

The value of oil as a fuel is undisputed and it has many advantages over the other forms of fuel, but heretofore its use has been limited, owing to its comparative scarcity. The greater value of petroleum as an illuminant, and the enormous demand which there is for it for this purpose has precluded its use as a fuel, excepting in occasional instances. If, however, the Texas oil is not adapted as an illuminant and is so distinctly a fuel oil, and if moreover the present abundant supply continues, its use as a fuel in many localities, particularly along the Atlantic Seaboard, may be confidently predicted. It forms a particularly favorable fuel for use in cities where the ordinances against the smoke nuisance do not permit of the use of bituminous coal. The practicability of petroleum as a fuel has been proven conclusively, and it is no longer an untried fuel. The problem of burning petroleum has been successfully solved both here and on an extensive scale in Russia, where it has been used for years upon the railways and steamboats.

The recent oil discoveries in Texas and on the Pacific Coast lend especial interest to some facts just presented by the Treasury Bureau of Statistics regarding the exports of mineral oils from the United States. These show that the exportations of the fiscal year about to end will probably be the largest in the history of this remarkable industry, which has increased its exports from 204 million gallons of illuminating oil in 1875 to 721 million gallons in 1900. In the quarter-century from 1876 to 1900 the total value of mineral oils exported from the United States was about \$1,200,000,000, an average of about \$48,000,000 a year, and during recent years has averaged about \$60,000,000 per annum, or \$5,000,000 per month.

In the mere question of gallons of oil produced Russia has been for years a close competitor of the United States, though it is probable that the recent discoveries in the United States will enable it to continue to lead in the number of gallons produced; while the fact that American oil produces nearly twice as much refined illuminating oil from a given quantity of crude, as from

the Russian oil, adds greatly to its value as a commercial product. One especially interesting feature of the development of the oil industry is, that there has been a remarkable decrease in the price to the consumer during the period in which the actual exportations and the net value of the exports have been increasing. The average value of the illuminating oil exported in 1876 was about 15 cents per gallon, and in 1877, an exceptional year, 20 cents per gallon. By 1881 the price had fallen to about 10 cents per gallon, the figures for that year being 332 million gallons, valued at \$34,000,000. By 1891 the average price was about 7 cents per gallon, the exports of that year having been 564 million gallons, valued at \$41,000,000. By 1898 the average export price was about 5 cents per gallon, the quantity exported having been 824 million gallons, and the value reported to the Bureau of Statistics by exporters through the customs collectors \$42,922,682. In the nine months of the present fiscal year for which the figures are completed by the Treasury Bureau of Statistics, the total exports of illuminating oil amounted to 569,624,751 gallons, valued at \$37,939,514, or 6½ cents per gallon; while the total value of all mineral oils exported, including crude, lubricating and illuminating oils, naphthas and residuum was \$52,745,096, and for the full fiscal year seems likely to amount to \$70,000,000.

STANDARD MINERS' INCH.

THE Legislature of California at its recent session passed the following Act which was approved March 23, 1901 and which established a standard miners' inch in that State.

SECTION 1. The standard miners' inch of water shall be equivalent or equal to one and one half cubic feet of water per minute, measured through any aperture or orifice.

SECTION 2. All Acts or parts of Acts inconsistent with the provisions of this Act are hereby repealed.

SECTION 3. This Act shall be in effect and force sixty days from and after its passage.

Michigan College of Mines.

The Michigan College of Mines is at present planning for the erection of two much needed buildings, which have been provided by the Legislature of the State—one of them is to be for the Departments of Civil and Mining Engineering and the other for the Departments of Chemistry and Metallurgy.

The Mining Engineering building will provide Mining and Hydraulics laboratories together with lecture and class rooms, all equipped with modern appliances. The amount allowed for its construction and equipment is \$42,500.

The building devoted to Chemistry and Metallurgy with its equipment will cost \$35,000. Its laboratories will be fitted up in accordance with modern ideas of lighting, plumbing, and ventilation.

The appropriation provides also for an addition to the present Engineering building which will accommodate the course in Blacksmithing. The equipment of the Electrical laboratory will be extended, and the central heating plant enlarged to take care of the added buildings.

The college is closing one of its most prosperous years, with an enrollment exceeding that of any former year. The classes for the practical work in Surveying and for Shopwork are especially large. With the increased facilities for instruction which the new buildings and equipment will furnish, the college may hope for still wider success during the coming years.

The International Mining Congress.

Among the interesting and educational features of the coming session of the International Mining Congress, which will meet in Boise, Idaho, July 23, 24, 25, 1901, will be the mountain scenery, journeys to many of the noted mines of the State, a trip to Baker City, Oregon, and an excursion to the "Yellowstone Park," the wonder of the world for scenic beauty, and the sportsman's paradise.

Delegates to the Congress will be accorded the unusual privilege of seeing these attractions together with a visit to Shoshone Falls, Swan Falls, Silver City, Weiser, Coeur d'Alene, Seven Devils, with others now being outlined by the entertainment committee.

The citizens generally of the State of Idaho and especially those residing in Boise are taking an enthusiastic interest in this session of the Mining Congress, and are making every effort to give the visiting delegates and their friends a royal reception.

The Western Passenger Association has already granted a one-fare rate for the round trip, plus \$2, and it is hoped that corresponding concessions will be granted by every railroad company in the United States and Territories.

Oregon, California, Missouri, Tennessee, and Ohio will enter the field as contestants for the session of 1902; and with this end in view, are coming to Boise strong in numbers, with a magnificent display of minerals.

The members of the Congress will be able to visit and examine some of the great mines of Idaho and adjoining States from which the precious and base metals are being taken. To many of them this will be a new and instructive experience, and will give them a broader and more liberal appreciation of the importance of the great basic industry on which rests so much of the prosperity of this entire nation, and which, during the year 1900, contributed over a billion dollars to its general commercial progress.

The objects of this Congress are to secure better recognition of the mining industry by the National Government, to bring about needed changes in the Federal mining laws, to cultivate acquaintance, fraternal feeling and hearty cooperation among the various mining, manufacturing, transportation, commercial, and labor bodies represented, and to exchange practical ideas covering the various phases of the mining industry, and, especially, to take under advisement the importance of the creation, by the Congress of the United States, of a department to be known as the Department of Mines and Mining, thus securing a cabinet officer representing an interest which effects more than one-third of the people of the United States.

BOOK REVIEW.

NOTES ON SOME BLOWPIPE TESTS, by Jos. W. Richards. 3 pages. REASONS WHY. Issued by the Passenger Department, B. & O. R. R. Co. 40 pages.

GUIDE TO WASHINGTON. Issued by the Passenger Department of the B. & O. Railroad. Illustrations and Maps. 41 pages.

INSTITUTION OF MINING AND METALLURGY, Broad Street House, New Broad Street, E. C. London. List of the Members. 52 pages.

CALENDAR OF THE SCHOOL OF MINING, KINGSTON, ONTARIO, NINTH SESSION, 1901-1902, by the Secretary of the School of Mining. 87 pages.

THE MEASUREMENT OF GOLD AND SILVER BUTTONS IN QUANTITATIVE BLOWPIPE ASSAYS, by Joseph W. Richards, South Bethlehem, Pa. 10 pages.

BIBLIOGRAPHY OF CLAYS AND THE CERAMIC ARTS, by John Casper Branner. Bulletin No. 143 of the United States Geological Survey, Washington, D. C.

VEIN STRUCTURE AT THE REYNOLDS MINE, GEORGIA, by G. E. Collins. A paper read before the Institution of Mining and Metallurgy, London, Eng., May 15, 1901. 7 pages.

NOTES ON BRINE AND OIL WELLS IN WESTERN CHINA, by J. V. Burn Murdoch. A Paper read before the Institution of Mining and Metallurgy, London, England, May 15, 1901.

THE ASSAYING OF COMPLEX GOLD ORES, by Ernest A. Smith, Assoc. R. S. M. A Paper read before the Institution of Mining and Metallurgy, London, England, May 15, 1901. 38 pages.

SEVENTH BIENNIAL REPORT OF THE BUREAU OF LABOR AND INDUSTRIAL STATISTICS OF NEBRASKA, 1899-1900. Sidney J. Kent, Deputy Commissioner, and A. H. Gleason, Chief Clerk. 633 pages.

CHOROLQUE TIN MINES AND ALLUVIAL DEPOSITS, BOLIVIA, by Malcolm Roberts. A paper read before the Institution of Mining and Metallurgy, London, England, May 15, 1901. 4 pages.

PROCEEDINGS OF THE INTERNATIONAL CONGRESS OF MINING AND METALLURGY HELD IN PARIS IN THE SUMMER OF 1900. Published at Saint Etienne under the auspices of the Society of Mineral Industry. 240 pages.

THE MANGANESE ORES OF BRAZIL, by Herbert K. Scott. Reprinted from the "Journal of the Iron and Steel Institute," No. 1, for 1900. Published at the offices of the Institute, 28 Victoria St., S. W. London. 40 pages and additional illustrations.

MINES AND QUARRIES. General Report and Statistics for 1900. Part I, District Statistics. Statistics of the persons employed, output, and accidents at mines and quarries in the United Kingdom, arranged according to the inspection districts. Issued by Mining Statistics Branch, Home Office, Whitehall, London. 52 pages.

PRELIMINARY REPORT OF A RECONNAISSANCE ALONG THE CHANDLAR AND KOYUKUK RIVERS, ALASKA, IN 1899, by Frank C. Schrader. 38 pages. A RECONNAISSANCE FROM PYRAMID HARBOR TO EAGLE CITY, ALASKA, by Alfred Hulse Brooks. 54 pages. A RECONNAISSANCE OF THE CHITINA RIVER AND THE SKOLAI MOUNTAINS, ALASKA, IN 1899, by Oscar Rohm. 40 pages. Published

by the Department of the Interior, U. S. Geological Survey, Washington, D. C., Chas D. Walcott, Director.

A TEXTBOOK OF GEOLOGY, by Albert Perry Brigham, Professor of Geology, Colgate University. Published by D. Appleton & Co., New York. 463 pages. Price \$1.40. This book is intended for secondary schools and it is admirably suited for this purpose. It is beautifully printed on good paper and the illustrations are numerous and of a high grade. They are almost entirely new and are excellent as explanatory of the text. The book is written in an interesting manner and should prove an excellent elementary textbook.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION FOR 1899, S. P. Langley, Secretary, Washington, D. C. 672 pages, illustrated. In addition to a statement of the administrative work of the Smithsonian Institution, this volume contains 31 scientific papers of great interest and covering a wide field. Those of particular interest to the mining profession are: The Growth of Science in the Nineteenth Century, by Sir Michael Foster. An Estimate of the Geological Age of the Earth, by J. Joly. Review of the Evidence Relating to Auriferous Gravel Man in California, by William H. Holmes. A Century's Progress of the Steam Engine, by R. H. Thurston.

CLAYS OF NEW YORK, by Heinrich Ries, Ph. D. Bulletin 35 of New York State Museum, Albany, N. Y., F. J. H. Merrill, Director. 944 pages. This report is an enlargement of Bulletin No. 12 published by the New York Bureau and it brings the information upon the clays of New York up to date. Dr. Ries is a well-known expert upon the subject of clays and this report is one of the many valuable additions he has made to the literature upon this subject. It includes the preliminary portion giving the properties of clays and the geological distribution in New York State and general occurrence in the United States. The major part of the book is taken up with the economic side of the question and has to do with clay working in its various forms. The chapter on the physical properties of clay is of particular interest as Dr. Ries made a special trip to Europe to investigate this subject in reference to the clays of Europe.

SYLLABUS OF A COURSE OF LECTURES ON ECONOMIC GEOLOGY, by John C. Branner, Ph. D., Professor of Geology, and John F. Newsum, A. M., Assistant Professor of Mining and Metallurgy in Leland Stanford Junior University, Stanford University, Cal. Second edition. Price \$2.50. 368 pages. The second edition of this Syllabus is a very great improvement on the first edition which appeared several years ago, more particularly in the way of the illustrations which have been added and which add very greatly to the value of the work. This Syllabus although intended and prepared for college students is an excellent reference book and guide for any one wishing to look up any of the subjects connected with economic geology, as the classifications under the various subjects are complete and clear and the references very full. As an outline for a course in economic geology, it would be difficult to find a better text. The only point that we can find to criticize is the index which would be more useful if it were much more complete. In its present shape, it is more nearly a table of contents than an index.

ARKANSAS GEOLOGICAL SURVEY, Annual Report 1892. Vol. V. Zinc and Lead. J. C. Branner, Ph. D., LL. D., State Geologist, Little Rock, Ark. 375 pages. The material for this report was collected by Dr. Branner while he was still State Geologist of Arkansas but no appropriation was made for printing reports until 1899, which accounts for the delay in publication. Chapter II which treats of the Economic Geology of Lead and Zinc Ores will be particularly serviceable at the present time when there is so much interest being taken in the lead and zinc ores of Southwestern Missouri and the neighboring States. The other chapters of the book take up the different sections of the zinc and lead district and describe each in detail. Chapter V deals with the subject of Methods of Prospecting. Chapter VI contains a list of the minerals found in the zinc and lead region of Northern Arkansas. Chapter VII is by Mr. E. S. Williams and treats of the Paleozoic Faunas of North Arkansas. Chapter VIII is a Bibliography of the Geology of North Arkansas. The report is well and copiously illustrated and is accompanied by a useful atlas.

TECHNICAL GAS ANALYSIS, by Frank H. Bates. Published by the Philadelphia Book Co., Philadelphia, Pa. 96 pages. Price \$1. This volume is a reprint of a series of articles published by the author in the Journal of Electricity under the title of "Industrial Gas," and is the first of a series of volumes which will be issued upon allied subjects. The book is simply written and while of course it is not intended to compare with the more elaborate treatment of the same subject by Hempel, it is an excellent guide book for those having to do with the analysis of gases. The scope of the book is shown by the following chapter headings: Chapter I, Collection of Samples. Chapter II, Methods of Gas Analysis. Chapter III, The Orsat Apparatus. Chapter IV, The Elliott Apparatus. Chapter V, The Hempel Apparatus.

Chapter VI, Measurement of Gases. Chapter, VII, Properties of Gases. Preparation of Reagents Employed. Most of the apparatus described is illustrated and the book should serve as an excellent one for those who do not care to go into the subject as deeply as the more elaborate treatises on the same subject.

PERSONALS.

John P. Brennan, general superintendent of the Eureka Fuel Co., Leckrone, Pa., has resigned.

Herman Justi, Commissioner Illinois Coal Operators Association for several years, has been reelected to that position for another year.

Prof. I. C. Russell, Professor of Geology at the University of Michigan, has been appointed State Geologist of New Jersey to succeed John C. Smock, who recently resigned.

Priestly Toulmin, formerly chief engineer of the Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., has resigned his position to engage in business for himself, being succeeded in the office by B. E. Morrow.

Prof. Ira Remson, for a number of years head of the Department of Chemistry at the Johns Hopkins University, has been elected president of that university to succeed President Gilman, whose resignation was recently accepted.

Thomas D. Morgan, mine foreman of the Berwind-White Coal Co., at Horatio, Pa., has tendered his resignation and has accepted the position of mine superintendent for the Lackawanna Iron and Steel Co., at Vintondale, Pa. Mr. Morgan was over nine years in his former position.

Giles B. Bosworth recently retired from the H. C. Frick Co. after having been continuously in the service of that company for the past 23 years. In 1876 Mr. Bosworth became shipper for the Henry Clay Works, in Fayette County, and from that position he has gradually advanced through the offices of auditor, secretary, and treasurer, and at the time of his retirement, he was vice-president, treasurer, and a member of the board of directors.

W. P. DeArmit, for many years president of the New York & Cleveland Gas Coal Co., Pittsburg, and his brother, T. B. DeArmit, superintendent of mines, Turtle Creek, Pa., have severed their connection with that company, which now belongs to the Pittsburg Coal Co. They are the prime movers in the formation of the Empire Coal Co., which was recently incorporated under the laws of West Virginia, and which will operate in Ohio and West Virginia.

The Oliver Iron Mining Co., the Lake Superior Iron Co., and the Regent Iron Co., parts of the United States Steel Corporation recently accepted the resignations of Mr. Henry W. Oliver, president, and D. G. Kerr, vice-president. Mr. T. F. Cole, general superintendent of the Oliver Iron Mining Co., was elected to succeed Mr. Oliver as president and general manager of all the companies. Nelson P. Hulst was elected vice-president and general mining engineer. Both of these gentlemen have headquarters in Duluth.

John C. Bullitt, of Philadelphia, who has been elected president of the Kingston Coal Co. to succeed the late Hon. Daniel Edwards, is among the best known men of the Quaker City and is an attorney of international reputation. He is a director of one of the large banks of that city and proprietor of the Bullitt Building on Fourth Street. He is best known, however, as being the author of the Bullitt Bill, which governs the City of Philadelphia. Other officers elected last week are: Vice-President, E. Waterman Dwight, of Philadelphia; Treasurer, William B. Chamberlin, of Philadelphia; Secretary, Elliott R. Morgan, of Kingston.

James Gayley, first vice-president of the United States Steel Corporation, in charge of ore, dock and transportation department, has appointed David G. Kerr, of the Carnegie Steel Co., head of this department for the Pittsburg district. Mr. Kerr will have charge of the ore department and blast-furnace practice in the Pittsburg district. His position in relation to the Carnegie Company was a similar one, he being ore agent of the company and directing the distribution of ore at the furnace plants in Pittsburg. In his new position he will have this work in charge in relation to all the furnace plants of the United States Steel Corporation in the Pittsburg district, including those of the American Steel Hoop Co. and the American Steel & Wire Co.

George T. Robinson, manager of the Cambria Steel Co.'s coke interests in the Connellsville region, who succeeded the late Martin Meagher, has been promoted to be manager of the company's mining interests at Johnstown and vicinity. These holdings include among them the largest mine in the Cambria

district. He will be succeeded here by John N. Pott, who has been with the Cambria Company as a mining engineer at Johnstown. Since the coke plants of the Cambria Company in the Connellsville region began to wane for a lack of coal supply their developments in Cambria County have expanded correspondingly. Of the company's 935 ovens in Connellsville region only a little over 400 are making coke, Morrell, the largest plant, having but 50 of its 400 ovens producing. At Johnstown a large by-product coking plant has been erected which partly makes up for the decreasing supply of coke from that district.

Mr. A. N. Humphreys, for many years general superintendent of the Westmoreland Gas Coal Co., with headquarters at Irwin, Pa., has accepted a position as general superintendent and mining engineer of all the collieries of the Ellsworth Coal Co., with headquarters at Ellsworth, Pa. The Ellsworth Coal Co. have 16,000 acres of coal land in the neighborhood of Ellsworth, with four new shafts and five more to be sunk. They also have collieries on the Youghiogheny and Monongahela rivers, and others in Ohio and Michigan. They also own some 8,000 acres of coal land in West Virginia, which will shortly be developed. Mr. Humphreys' extensive experience in his younger days in the anthracite regions of Pennsylvania, and for some years past in the gas coal field of Westmoreland County, eminently fits him for the responsibilities of the position he has just accepted.

The following are biographical details regarding the three gentlemen who have each been awarded an Andrew Carnegie Research Scholarship of £100 by the Council of the Iron and Steel Institute of Great Britain:

Alfred Stansfield, D. Sc., (Lond.) Assoc. R. S. M., was born on March 18, 1871. He was educated at Ackworth School, the Bradford Technical College, and the Royal School of Mines, where he was awarded, in 1893, the first Honours Associateship in Metallurgy. In 1898 he was appointed instructor in assaying at the Royal College of Science. From 1891 to 1898 he made a number of researches for the Alloys Research Committee of the Institution of Mechanical Engineers. He has read before the Iron and Steel Institute, of which society he is a member, two papers on the solution theory of carburized iron. He is the author of a paper on thermo-electric pyrometry in the Philosophical Magazine, and joint author of a report on alloys presented to the International Physical Congress in Paris last year.

John Alexander Mathews, Ph. D., M. A., B. Sc., F. C. S., of Brooklyn, United States, was born on May 20, 1872. He was educated at Washington and Jefferson College, and at the Columbia School of Mines, New York. He is the author of some ten papers in the Journal of the American Chemical Society, and in the New York School of Mines Quarterly.

Julius Goldberg, of Leoben, Austria, was born on April 15, 1876. He was educated at Kalish in Russia, and at the University of Warsaw, and the Leoben School of Mines. He has had experience of practical metallurgy at Kertsch in Russia, and at Wissen in Germany.

G. M. Williams, mine inspector of the Fourth District at the present time, and for the past 21 years an anthracite inspector, has accepted the management of the coal properties of the Kingston Coal Co., and has therefore tendered his resignation as inspector to Governor Stone. Mr. Williams' loss to the inspection service of the State will be a very serious one as no one of the Pennsylvania inspectors was held in higher esteem by everyone connected with the anthracite industry. Mr. Williams was born in Ystradgynlais, Breconshire, South Wales, August 14, 1841, and was a son of Morgan and Margaret Williams. He attended school in his native town until he was 11 years of age, when he left school and began work in the mines as a door boy. He came to this country in March, 1859, and located at Beaver Meadow. He secured employment as a driver boy at the Ratcliff and Johnson mine, Coleraine, and continued at that work until he was 18 years of age when, dissatisfied with the wages he was earning, he gave up that position and secured work at mining. He continued at that work for 14 years, being employed at Jeanesville, Ebersvale, and Scranton. On July 1, 1873, he was made foreman of the Oxford and Bellevue collieries of the Delaware, Lackawanna & Western Railroad Co., in Scranton, and remained in that position until June 30, 1880, when he tendered his resignation to become mine inspector, having been appointed to that position by Governor Hoyt. He assumed his duties as inspector July 19, 1880, and has continued in the same position ever since, having been reappointed five times. Mr. Williams now resides at Wilkes-Barre.

The Bullock-Wagner sales organization has established a district office at No. 1624 Marquette Building, Chicago. It will be in charge of Mr. H. B. Foster, who has for about two years served the Wagner Co. as sales agent. He will have the able assistance of Mr. E. W. Goldschmidt, formerly of the Western Electric Co., in covering this most important field.

CORRESPONDENCE.

This Department is intended for the use of those who wish to express their views, or ask or answer questions on any subject relating to mining. Correspondents need not hesitate to write for supposed want of ability. If the ideas are expressed, we will cheerfully make any correction in composition that may be required. Communications should not be too lengthy, and personal reflections should be carefully avoided. All communications should be accompanied with the proper name and address of the writer—not necessarily for publication, but as a guarantee of good faith. The editor is not responsible for views expressed by correspondents in this Department. Correspondence should be in as simple language, and as free from technical terms and formulas as possible, consistent with clear solution. Questions on subjects not directly connected with mining will not be published.

Hydraulic Ram.

Editor Mines and Minerals:

SIR:—What conditions are necessary for the successful operation of a hydraulic ram.
A. FRED ANDERSON.
Grantsville, Utah.

Dry Washing Ground.

Editor Mines and Minerals:

SIR:—Please state what is the lowest value ground treated successfully by dry washing in New Mexico, Arizona, and Southern California.
JOSEPH BRADBURN.
Syracuse, N. Y.

Tempering.

Editor Mines and Minerals:

SIR:—Will some of your correspondents kindly give information regarding a good tempering solution for chain-machine bits?
Very truly yours,
J. T. PHILLIPS.
St. Charles, Mich.

Silver Plating.

Editor Mines and Minerals:

SIR:—We have some copper plates at our stamp mill which have been silver-plated and the plating is about all off; we have a 110-volt direct-current dynamo; could you or some of your subscribers give me directions how to resilver them, they are about 3 ft. $\times$ 6 ft. How large a silver plate would we have to have?
G. W. HUBBARD.
Dahlonega, Ga.

To Mine Cheap Commodities.

Editor Mines and Minerals:

SIR:—Please enlighten me what is the cheapest underground mining by shaft and on cages on low-priced commodities outside of coal that you know of. At Brazil, Ind., they pick, blast, and hoist out through a shaft clay to make sewer pipe at less than 25 cents a ton. I have in view a deposit of lowgrade asphaltic sandrock which will have to be mined from underground by shaft.
M. SCHNEIDER.
New York, N. Y.

Keeping Timbering Plumb in an Inclined Shaft.

Editor Mines and Minerals:

SIR:—Can you give a correct method of keeping in plumb while sinking an inclined shaft which has a pitch of 64 degrees. I have noticed several failures among carpenters who were doing the timbering and seen, after reaching a depth of two or three hundred feet, that the cable with a loaded bucket does not pull directly over the skids in hoisting, but touches the end or side timbers. Please explain with diagram.
W. R. COOPER.
Susanville, Ore.

Coulterville, Illinois.

Editor Mines and Minerals:

SIR:—Coulterville, Illinois, has been the scene of considerable activity in the coal business this spring. Mr. J. M. Jones has practically opened a new mine by moving his hoisting plant to a larger shaft that was formerly used as an air shaft. This shaft will be fully equipped for work in another month, and a large output is expected, as the entries are all in good coal and the haulage roads will be greatly shortened by the change. It is reported that five new shafts will be sunk here in the near future. The Coulterville seam consists of a fine quality of bright, clean bituminous coal, an excellent coal for steam or domestic purposes. The seam varies from 6 feet to 8 feet in thickness and is overlaid with lime rock varying from 8 feet to 18 feet in thickness. Another seam of coal of the same thickness as the seam worked lies 80 feet below and a 3-foot seam of excellent coal 80 feet above this one.
X

Gold in North Carolina.

The first gold found in the United States was discovered within a few (30) miles from Charlotte in the form of a 28-pound nugget, used for many years as a door weight to a cabin door.

On April 10, 1896, a lump of gold weighing 22 pounds was found at the Reed mine, a fac-simile of which may be seen at the United States Mint in Charlotte, where is located the first mint established in the United States. Millions of gold half eagles, quarter eagles, and gold dollars were coined here before the war, since when, the old miners of early days having taken the California gold fever left never to return, mining has not until recently received the attention it deserves.

Some of the streets of Charlotte run over tunnels of two old-time mines that produced over \$5,000,000 in gold. The Rudisill mine at a depth of 400 feet with 3,500 feet of workings has produced \$2,600,000 in gold. The St. Catherine, upwards of \$2,000,000 and the Copps \$2,300,000.

A revival of mining is on foot in this section. Mr. C. A. Ames, a Colorado mining man, learning of the early history of these mines, came here to investigate the district two years ago, since when much has been done in the way of development. In former days most of the properties were abandoned at water level, after shipping rich surface ores to New Jersey at heavy expense of \$25 to \$35 per ton for freight and treatment. Capital will eventually become interested again in the old-time mines. In the meantime new veins are being opened up that promise to outshine the old producers of the early days. The Atlanta Smelter is opening up the McCombs mine on an extensive scale—having already over 3,000 tons of milling ore in the dump—developing with intentions of erecting a 20-stamp mill. The Woolworth, formerly called the Grier mine, recently purchased by F. W. Woolworth, a New York millionaire, is being extensively developed. The Haile mine is producing an average of about \$12,000 per month, running 60-stamp mill. The Va. & Carolina Gold Mining Co. has recently completed a 10-stamp mill, with Wilfley concentrator, at the Summerville mine, and likewise the Champion Mining Co. There is some talk of a smelter in the near future. This has been a long felt want.

Charlotte, N. C.

WILLIS M. AMES.

Method of Opening and Ventilating a Mine.

Editor Mines and Minerals:

SIR:—I would like to ask if you would kindly answer the following questions which appeared in the last examination of mine foremen held at Pottsville?

(1) State how you would open a colliery to work the Primrose, Holmes, Mammoth, Skidmore, and Buck Mountain seams on a pitch of 45°, each seam giving off gas freely. Give dimensions of slope airways or other openings.

(2) Describe in a general way how you would ventilate the above colliery, and show where you would place your ventilators or fans, and how you would apply them so as to produce the best results.
MINE FOREMAN.

(1) The general method of opening a colliery so as to mine the seams mentioned, on a pitch of 45°, would be to drive a pair of slopes in the lowest or Buck Mountain seam, provided the surface arrangements could be located at the outcropping of this seam. The slope should be driven to the lowest limit it is desired to work the seams, if practicable, or, say 1,500 yards. At the foot of the slope a cross tunnel is driven connecting the other seams. Where the tunnel cuts each seam, gangways are driven to the right and left in those seams, and the coal worked to the rise from these gangways. It is generally preferable to keep the breasts in each of the lower seams some 10 yards in advance of the breasts in the seam immediately above it. The gangways are driven preferably near the roof of the seam and a small monkey airway above the gangway. Loading chutes are driven off from the gangways at a proper loading angle, until the floor of the seam is reached when the breast is opened up. Between adjoining loading chutes a small manway is driven across the seam until it approaches the floor of the seam where it is branched to the right and left in the form of a letter Y, and connects with the breast manway upon each side. At the point where this manway divides, a battery is placed to divert the air current to the face of the breast. At this point also a small crosscut is driven up to the monkey airway above it. This is for the purpose of conducting the air past any breast or any number of breasts, and is used in case of accident at the face when it is desired to isolate the breast or breasts.

The size of the main slope and airway must be proportioned according to the magnitude of the workings. The anthracite mine law requires that not more than 75 men shall work upon the same split or current of air, and that they shall receive not less than 200 cubic feet of air per man per minute. Assuming that only one lift is being worked at a time, which would give a gangway to the right and left in each seam or 10 separate splits or air currents in all, and also assuming that 75 men are working at one time upon each split, we obtain for the entire quantity of air in circulation, $200 \times 75 \times 10 = 150,000$ cubic feet. The velocity of the air current in the main slope should not exceed 25 feet per

second (1,500 feet per min.) which would require a sectional area for the main slope of $\frac{150,000}{1,500} = 100$ sq. ft. If it were desired to provide for the working of two lifts in each seam, it would be necessary to drive two main slope return airways, one upon each side of the haulage slope or intake, making each airway $10' \times 10' = 100$ square feet in sectional area. In this case it would be necessary also to provide a second intake opening either in the form of a shaft or slope driven in one of the other seams. Two exhaust fans would preferably be employed under these circumstances, one being located at the mouth of each return slope airway.

(2) The ventilation of the above mine has been partly described in answer to the preceding question. The ventilation of the breasts may be best accomplished by arranging the breasts in groups of from 4 to 10, according to the quantity of gas being given off at the working face. Each group of breasts should receive its own air current from the gangway or intake. The air passes up the manway leading to the last or inside breast of each group, and from thence passes along the working face of each breast in the group to the first or outside breast of the group, whence it returns down the manway and through the crosscut to the monkey airway, by which it is returned to the main slope at the side of the haulage road. By this means each group of breasts has its own circulation, and there is less risk or danger incurred in case of an explosion occurring in any breast. The circulation in each group of breasts can be regulated according as the conditions require. This is virtually applying the panel system to the ventilation of inclined seams. J. T. B.

British Columbia Mining News.

The Slocan mining division has exported 1,734 tons of ore up to date this year.

The Ivanhoe mine near Sandon has closed down.

Work has been resumed on the Maybe near Ferguson, where they are driving a 200-foot tunnel.

At the Alice mine near Creston the vein has been cut at the 250-foot level and proves to be of very good value, the grade of ore being the same as the 100-foot level, the vein being about 3 feet wide. The ore is silver-lead, and runs very high in lead, carrying 20 to 30 ounces silver to the ton. The property is managed by T. G. Proctor, of Nelson.

The Miner-Graves syndicate will resume work on the Rockland mine near Silverton at an early date. The machinery will be installed and the mine properly developed.

At the Richelieu Consolidated mine near Crawford Bay a tramway will be constructed during the summer connecting the mine with the end of the wagon road. This tramway will be something over 8,000 feet in length, and will enable the company to ship the year around. Heavy shipments will be made as soon as the tramway is completed.

Active development work will be commenced at once at the Second Relief mine near Erie. A saw mill and stamp mill will be constructed in the near future, and other improvements made to thoroughly develop and operate the mine.

The Tit-for-Tat group in East Kootenay has been bonded to Eastern Canadians for \$50,000. This is a free gold property and carries high values. Active development work will be commenced on the property at once and machinery added to the property as soon as required.

A rich strike of free gold ore has just been made on the Sir Wilfrid group on Pool Creek in the Lardeau mining division. The ore assayed over \$1,400 per ton in gold. The strike has created a great deal of excitement in the Pool Creek camp.

A big strike has just been made in the Silver Cup mine at Ferguson. The ore body encountered is over 2 feet wide and contains ore running over 400 ounces silver and 3 ounces gold to the ton. The Silver Cup is probably one of the richest silver-lead mines in the Lardeau, and much is expected from this property in the future.

The Minnesota Mining & Development Co. has purchased the Nellie group on Lexington Creek in the Lardeau mining division, and will begin active development work as soon as the snow will allow.

The Lone Star group on Nettie L. Hill near Ferguson has just been sold to Toledo (Ohio) capitalists, who will begin driving a 250-foot tunnel at once. The property consists of three claims.

The Comstock Co., of London, Ontario, will commence active development work on its property in the Lardeau as soon as the snow is off. The company was organized by A. E. Walsh.

The Metropolitan group on the north fork of Lardeau above Ferguson will be actively developed this season under the management of Charles W. McCrossan.

The manager of the V. & M. mine at 12 Mile, Slocan district,

has decided to put in machine drills, as the rock is very hard and little headway can be made by hand work. As soon as the machinery is installed a large increase will be made in the staff of the mine. The full returns from a carload of ore shipped from this property to the Trail smelter netted \$43.60 per ton.

The last payment on the Black Hawk and Daisy claims has just been made by Rene Laudi. This property is located on the north side of Ten Mile Creek in the Slocan district.

The Bear Creek Mining Co., organized by Seattle citizens, will operate a new territory in Cassiar district. This district is situated about 75 miles from Skagway. The property to be developed consists of placer claims on Bear and Clear creeks. A government wagon road is now being built to the new diggings, and will be completed shortly.

The Ashcroft Journal reports that the large bank blast at the Consolidated Cariboo hydraulic mine, at Bullion, was successfully exploded and produced very satisfactory results. This blast contained 4,540 kegs (equal to 113,500 lb.) of powder, which was distributed in 1,200 feet of powder drifts across the bank from rim to rim. The explosion raised the bank about 20 feet over an area of 4 acres of ground, and this disintegrated about 2,000,000 yards of gravel. This is probably the largest bank blast that was ever exploded in a deep gravel mine on the Pacific coast or anywhere else. The mine has been operated continuously since April 20, and the outlook is very favorable for a larger clean-up than any secured during the previous season.

The Anderson Lake mines operated by the Anderson Lake Mining & Milling Co. in the Lillooet mining division are being successfully operated under the management of W. E. Brett of Lillooet. There is a five-stamp mill on the property which produced about \$2,000 in bullion last month. There is a large vein of free gold quartz on this property, and while it is low grade the success of the mine is only depending upon increased mill capacities.

Nelson, B. C.

ANDREW F. ROSENBERGER.

TRADE NOTICES.

The Capell Mine Fan Co. is making important additions to its plant at Jeannett, Pa.

The Burt Mfg. Co., of Akron, Ohio, has recently equipped the San Juan Light & Transit Co., Porto Rico, with Cross oil filters.

A. Leschen & Sons Rope Co., 920-922 North 1st St., St. Louis, Mo., the well-known makers of the Patent Flattened Strand and other ropes, have distributed a very neat desk blotter.

The Harrow Spring Co., of Kalamazoo, Mich., has contracted with Wm. B. Scaife & Sons, Pittsburg, Pa., for a number of steel-frame structures. The main building will be 290 ft. long $\times$ 90 ft. wide $\times$ 32½ ft. high.

The coal mining department of the Lackawanna Iron & Steel Co., Vintondale, Pa., is inviting proposals for the sinking of four shafts and two rock slopes at its new collieries at Vintondale, and would like to have it so known among contractors.

The new plant of the Wilmington Railway Spring & Mfg. Co., at Washington, Pa., was designed by Wm. B. Scaife & Sons, Pittsburg, Pa., who will also manufacture and erect the buildings. They are of steel-frame construction, with slate roofs and corrugated iron sides.

The Watt Mining Car Wheel Co., of Barnesville, Ohio, makers of mine and ore cars and car wheels and axles of every description reports an increasing demand for their products from over a very widespread territory which includes practically every mining field of the United States.

The Atlas Pipe Wrench Co., Flood Bldg., San Francisco, and 121 Liberty St., New York, has recently distributed to its friends a very neat and unique pocket match safe. The body of this is nickel with a neat celluloid cover containing the advertisement of the company.

The Union Steam Specialty Co., Scranton, Pa., have issued their new catalogue of steam specialties, and will be pleased to mail one to all applicants. The catalogue describes the Lippincott steam separator and exhaust oil extractor, the union furnace blower, indicators, reducing wheels, planimeters, steam traps, and other specialties of a like nature.

The contract for a complete central air compressing plant was awarded the McKiernan Drill Co., by Messrs. Shanahan, Woolfolk & Co., South Framingham, Mass., who have secured a large contract from the Metropolitan Water Board, Boston, Mass., for an aqueduct consisting of two tunnels, etc. The amount of the contract secured by the McKiernan Drill Co. is in the neighborhood of \$2,500.

The Exeter Machine Works, of Pittston, Pa., is at present installing a complete coal-handling system, employing the Exeter-LeGrand conveyer, for the Oxford Paper Co., Rumford Falls, Me.

The same company has recently shipped six improved 75 H. P. hoisting engines to Havana, and is at present installing a complete coal-handling system for the New York Gas, Electric Light, Heat & Power Co., 39th Street Station, New York City.

The Scranton Steam Pump Co., Scranton, Pa., have just issued a new catalogue of their pumps, and have devoted special attention to mining patterns. They have recently devised a new and novel process for lead-lining the working barrels of their pumps, and after this is done, they claim that the water ends are proof against the action of bad water, for an indefinite period. The new process enables them to lead-line pumps at a merely nominal cost, and is a thoroughly workmanlike job. They will be pleased to give all particulars of this feature of their business, and to send catalogue to all interested.

The office and business of the Wright Mfg. Co., manufacturers of high-grade steam specialties, Cleveland, Ohio, have been removed to Detroit, Mich., where the business of the company will hereafter be transacted.

James McCrea & Co., 67 W. Washington St., Chicago, manufacturers of steam specialties have made Knight & Jillson Co., Indianapolis, Ind., agents and they carry a complete stock of the Climax steam joint clamps and orders can be filled promptly by the following agencies: Barrett & Plowman, 11 N. Front St., Philadelphia, Pa.; Geo. I. Roberts & Bros., 471 Fourth Ave., New York; C. K. Nichols & Co., 40 Water St., Boston, Mass.; Knight & Jillson Co., Indianapolis, Ind.; Western Iron & Supply Co., St. Louis, Mo.; Mine & Smelter Supply Co., Denver, Colo.; Western Mining Supply Co., Butte, Mont.; Pierce, Bird & Co., San Francisco, Cal., and Kilbourne & Clarke Co., Seattle, Wash. It is often quite an advantage to the user of these clamps to be able to pick them up at nearer points than sending to the manufacturers for them.

The Sullivan Machinery Co., of Chicago, has recently become successor to the M. C. Bullock Mfg. Co., and in future will manufacture the complete line of diamond drills, rock drills, and mining machinery formerly put on the market by the two concerns. Since this change in management the Sullivan Co. has transferred the Western works into the larger and more commodious building formerly occupied by the Bullock Co. A line of Corliss air compressors and Corliss hoists of all sizes are now being built, which has necessitated the complete overhauling and enlarging of this plant. Two new buildings have lately been erected and are almost ready for use. The Sullivan Co. has recently extended its western agencies to the Pacific coast, and now in addition to the Denver office in charge of Mr. R. D. Hunter, a branch office has been opened in Spokane, Wash., under the management of Mr. M. J. Ready.

A new engine company has recently been started in the vicinity of Milwaukee, Wis. This company is known as the Brown Corliss Engine Co., and is capitalized at \$1,000,000. Its incorporators and officers are Julius Wechselberg, president; Walter S. Whiting, first vice-president and treasurer; and Walter F. Brown, second vice-president and general manager. The general offices of the company will be in Milwaukee, but the company has purchased 1,200 acres of land at Western Union Junction in Racine County, Wis., where it is proposed to erect a plant and to build a manufacturing town. The plant when complete will employ 500 men and will consist of a machine shop 500 ft. × 125 ft., and the foundry 400 ft. × 120 ft., both built of steel and brick and equipped with the most modern machinery, including electric cranes, and in addition there will be the necessary boiler and engine shops, forge and pattern shops and a fully equipped electric plant. Mr. W. F. Brown, the general manager, has been connected with Allis, Filer and Stowell, and other prominent engine builders. Mr. W. S. Whiting, who will have charge of the financial end of the business is the son of S. P. Whiting, of the Calumet & Hecla Copper Co. The company expects to have its product upon the market within six months.

The Ericsson Telephone Co., 296 Broadway, New York, has recently issued an interesting sheet of photographs which will be mailed to any person applying and mentioning MINES AND MINERALS. This photograph shows the two enormous factories of this company in Stockholm, Sweden, and St. Petersburg, Russia. It also shows the interior of the Telephone Exchange at Copenhagen, Denmark, which has a capacity of 10,000 subscribers and which is a magnificently appointed exchange in every way. Another very interesting view shows the Ericsson Multiple Switchboard in the Shanghai Exchange, China. The Ericsson Co. reports that the Mongolian operators are said to be very rapid and accurate. The manager of the Ericsson Co. also received recently a very interesting postal card from British India, at which place Ericsson telephones are being used and are giving excellent results. The interesting part of this is that they did not even know that such an exchange existed. The Ericsson telephone was awarded first prize at Paris, 1881; Madrid, 1883; Vienna, 1884; Stockholm, 1886; Copenhagen, 1888; Chicago, 1893.

Their exhibit in Paris, in 1900, was from the St. Petersburg, Russia, factory, which was also awarded first prize. This year their exhibit of a 50-subscriber switchboard and a few of their different telephones at the Pan American Exposition, at Buffalo, is made in Section 8 of the electricity building, and Mr. W. Jac Marland will have charge of exhibit. They extend to all their friends and patrons a cordial invitation to see their exhibit and talk over their instruments. They are exhibiting their goods in connection with others in a collective electrical exhibit, which will doubtless prove of interest to many of our readers.

Bituminous Mine Inspectors.

The following is a list of the mine inspectors recently appointed by Governor Stone, for the bituminous region of Pennsylvania: 1st District, Henry P. Louttit, Monongahela; 2d District, C. B. Ross, Greensburg; 3d District, Thomas K. Adams, Mercer; 4th District, Elias Phillips, Dubois; 5th District, Isaac G. Roby, Uniontown; 6th District, Josiah T. Evans, Johnstown; 7th District, James Blick, Idlewood; 8th District, Joseph Knapper, Philipsburg; 9th District, Bernard Callaghan, Connellsville; 10th District, Joseph Williams, Altoona; 11th District, W. J. Mollison, Scottdale; 12th District, Roger Hampson, Punxsutawney.

The Southwest Miners' Association.

The following notice has been received and it is also stated that earnest efforts are being made toward securing a good exhibit at the International Mining Congress at Boise City:

"The annual meeting of the Southwest Miners' Association will be held on July 9, 1901, at the rooms of the Association, at Los Angeles, Cal., at 8 o'clock, P. M.

"It is very desirable that all members of the Association should be present, as matters of great importance will come before the meeting, and new directors for the coming year are to be elected.

Signed,

THOMAS EWING, *President*,
H. G. JAMES, *Secretary*."

A. S. Cameron Steam Pump Works.

The A. S. Cameron Steam Pump Works, of New York City, have a very fine exhibit of their pumps at the Pan-American Exposition, at Buffalo, which should interest all engineers. The exhibit is in charge of Mr. P. E. Leahy, president of the National Association of Stationary Engineers, and consulting engineer for the Cameron Steam Pump Works. The exhibit consists of eight of the Cameron pumps, showing a variety of the direct-acting type and including the following: The "regular" type, for general service, the special "boiler feeder" pump, the vertical piston mining pump, vertical plunger sinking pump, the horizontal plunger station mining pump cut in sections for mule back transportation in mountainous countries, the sectional plunger sinking pump, the vertical engine and deep well pump for artesian wells, and a pump cut into sections to illustrate the mechanism and principle of operation of the Cameron type of pump. The exhibit is shown in the Machinery Division of the Transportation Building in Block No. 25. It need hardly be added that all visitors will be welcomed, and the various features of the exhibit will be shown in detail to all who are in any way interested.

American and Welsh Coal.

At a meeting of the Cardiff Chamber of Commerce, recently, a letter was read from the Foreign Office in regard to the position of the United States of America in the European coal market. The letter stated that the cost of Cardiff coal was about \$5, and the cost of freight from Cardiff to Naples \$2, making \$7 c. i. f. at Naples. The cost of American coal was \$2.50, and the freight from Philadelphia to Naples \$4, making \$6.50. The secretary stated that this showed a difference of about 2s. per ton in favor of Philadelphia coal, but explained that since the latter had been written the price of coal and rates of freight had varied. The chairman said that personally he did not think they had anything to fear from the quantity of coal that might come from Philadelphia into the European market. If they took the freight from Philadelphia at 18s. and the coal at \$3, that would make the coal about 30s. per ton at Genoa or Naples. Then, if they took the freight from Cardiff at 10s. 6d., and the price of best Welsh coal at 23s., that gave them 33s. 6d.—a difference of 3s. 6d. But if they considered the quality of the two coals, the result would be different. To give a proper comparison they must take 50 per cent. of best Welsh coal at 23s., and 50 per cent. of small at 15s. This would give a mean of 19s., and taking 10s. 6d. for freight this would give 29s. 6d. for Welsh coal, against 30s. for American coal.—*Colliery Guardian*.

MINE LOCOMOTIVES.

Electricity vs. Compressed Air—A Comparison of the Efficiencies and Relative Cost of Installation of the Two Systems.

Written for MINES AND MINERALS, by W. B. Clarke.

A very interesting article appeared in the November issue of MINES AND MINERALS entitled "Compressed Air Haulage Plant," and describing an installation at the No. 6 Colliery of the Susquehanna Coal Co., Glen Lyon, Pa. The article in question was a reprint of a paper read before the Canadian Meeting of the American Institute of Mining Engineers in August, 1900, by Mr. J. H. Bowden. A description of the same plant appeared in the "Colliery Engineer and Metal Miner," of May, 1896. The conditions obtaining in this mine are especially favorable for economical locomotive haulage, all grades being moderate and in favor of the load. General statements regarding the superiority of electricity as compared with compressed air, do not appeal to the technical engineer and it is necessary therefore to carefully consider a specific case. The requirements as outlined in the above mentioned paper are as follows:

NO. 6 SHAFT.

Haulage road, four thousand (4,000) feet one way.
Grades average 1.5% in favor of the load, maximum 2½%.
Total number of cars per 10-hour day 855
Average trip, fifteen (15) cars.
Weight empty trip, twenty-one (21) tons.
Weight loaded trip, seventy-three (73) tons.

NO. 6 SLOPE.

Haulage road, twenty-one hundred (2,100) feet one way.
Grades average 1.5% in favor of load, maximum 2½%.
Total number of cars per 10-hour day 320
Average trip, fifteen (15) cars.
Weight empty trip, twenty-one (21) tons.
Weight loaded trip, seventy-three (73) tons.

It will be noted that the average grade is specified as 1.5% rather than 1% as stated in the original article; in order that any error may be on the safe side. The tractive effort per ton against the grade is 60 pounds, thirty pounds for the grade and thirty for the track resistance. The loaded trip requires practically no power, as the grade is sufficient to just about overcome the friction. Each locomotive therefore exerts an average drawbar pull of 1,260 lb. (21 × 60) when hauling a train of fifteen empty cars.

The locomotive in Shaft No. 6 makes twenty-four round trips per day or a total mileage of thirty-six miles. At eight miles per hour the actual running time is four and one-half hours, leaving five and one-half hours for switching, making up trains, etc.

The size of a compressed-air locomotive is generally determined by the rate of consumption of compressed air, which depends upon the load, length of haul, and the topography of the track. To avoid too frequent charging, however, it was necessary to select a locomotive with large storage capacity, weighing about eight tons. The normal drawbar pull of a locomotive of this size is 3,000 lb., which is obviously much greater than is actually required to haul the loads above described.

Still erring on the safe side we will select an electric locomotive weighing six and one-half tons, the rated drawbar pull of which is 2,500 lb. at a speed of eight miles per hour. This locomotive would consume in electrical energy thirty-three kilowatts when hauling twenty-one tons on a 1.5% grade at a speed of eight miles per hour. If this locomotive were to work at its full capacity, as in every day practice, it would easily haul twenty-three empty cars up the maximum grade, namely 2½%. The regular trip, however should hardly exceed twenty cars on account of the presumable necessity of starting on a level track, the loaded trip weighing ninety-eight tons. The drawbar pull would be 2,940 lb. (98 × 30) which is well within the momentary overload capacity of the six and one-half ton locomotive. In actual practice the drawbar pull would be less as the train would be started "slack."

The service required of the slope locomotive is obviously much easier on account of the relatively short run, namely, 2,100 feet. This locomotive makes twenty-two trips per day, or a total mileage of 17.5, the actual running time being 2.2, leaving 7.8 hours for switching, making up trains, etc. When hauling the empty cars on a 1.5% grade at a speed of eight miles per hour this locomotive would also consume 33 kilowatts or a total of 66 kilowatts for both locomotives, assuming a load factor of 100%. The kilowatt input of both locomotives at their full rated loads would be 106 kilowatts (2 × 53) and, allowing 80% load factor, a much higher figure than is used in ordinary practice, a generator of 85 K. W. capacity would be required. So large a machine is not needed to meet the actual requirements upon which we are figuring, but the size of the generator should be such that the locomotives may be operated at their full capacity at any future time, as the output of the mine increases. In actual practice the writer would recommend for this plant a generator of at least 100 K. W. capacity, as experience has shown that the uses of electricity rapidly multiply; the subsequent installation

of motors for driving hoists, pumps, car conveyers, coke larries, etc., is almost a certainty.

The total output of this mine is about 2,100 long tons of coal, i. e., 675 cars per day, each containing 7,000 pounds of coal. The shaft motor, however, could very easily handle 480 cars, 24 trips of 20 cars each. Assuming the same running time, viz., four and one-half hours, the slope motor could very easily make 45 trips of 20 cars each and could easily handle 900 cars per day. Both electric locomotives could therefore handle 1,380 cars per day or 4,300 long tons of coal as compared with 2,100 tons, the capacity of the compressed air plant.

The following comparison of the first costs of the compressed air and the electric haulage plants is very interesting:

COMPRESSED AIR PLANT.	
Compressor	\$ 2,880.00
Extras for compressor repairs	75.75
Shaft motor	2,748.63
Slope motor	2,918.20
Extras for motor repairs	207.93
Air connections 5" line (6,000 ft.)	2,914.32
Air connections 3" line (4,000 ft.)	1,240.46
Steam connections to compressor	278.27
Material for compressor foundations and house and air-washing box	295.27
Labor on compressor house and foundations and 5" line, and installing shaft motor	1,188.01
Labor on 3" line and installing slope motor	46.95
Porter equalizing valves	372.21
Total cost of plant	\$15,156.00
Additional compressor recently installed	3,000.00
	\$18,156.00
ELECTRIC PLANT.	
One (1) 85 K. W., 500 volt, belt-driven generator	\$1,200.00
One (1) generator panel with rheostat	250.00
One (1) 100 H. P. engine (13" × 12")	750.00
One (1) endless belt	75.00
Two (2) 6½ ton electric locomotives	3,600.00
Feeder, trolley, and bond wire	800.00
Insulators and labor	600.00
Steam connections to engines	278.00
Material for foundation for engine, generator, and power house	400.00
Labor on power house	1,000.00
Freight, boxing, and contingencies	500.00
Total	\$9,453.00

In an electric haulage plant it is customary to use a relatively high-speed engine, which would consume per I. H. P. hour, 28 pounds of steam as compared with a consumption of 34 pounds by the air compressor. The most sanguine advocate of the compressed air system admits the low efficiency, especially of the high-pressure air compressor. The air is compressed to a pressure of 600 pounds, but as it is expanded to a pressure of 160 pounds in the auxiliary reservoir before being used it is obvious that the energy consumed in raising the pressure from 160 to 600 pounds is entirely wasted. The theoretical horsepower required to compress 100 cu. ft. of free air to a pressure of 160 pounds, in a three-stage compressor, assuming perfect cooling, is 18 H. P. compared with 29 H. P. to compress 100 cubic feet of free air to a pressure of 600 pounds. The energy lost at this point, therefore, is about 60% of that required to compress the air to a pressure of 160 pounds. The amount of energy dissipated by the various cooling devices may be appreciated from the fact that if the air were adiabatically compressed to 600 pounds its temperature would be 1,070° F. It is customary to build compressed air locomotives for a storage pressure of 1,500 and even 2,000 pounds where frequent charging is impossible; obviously the higher the storage pressure the lower the efficiency.

The air compressor load is fairly steady, as the chargings are quite frequent, and on account of the low efficiency of the compressor and locomotive, a boiler capacity of at least 300 H. P. is required, now that the second compressor has been added. Compared with this figure, the electric system with high efficiency generator, motors, and engine would require a boiler capacity not exceeding 150 H. P. The load is so intermittent that the addition to an existing steam plant of any size, of a 100 H. P. engine would require hardly any additional boiler capacity. Any bank of boilers which are not overloaded, possesses in itself a considerable storage capacity. The same statement is true of a separate boiler plant for the haulage system, as the load is very intermittent indeed and the boiler will readily respond to momentary overloads.

The operating expenses of the electric haulage system would not be much less than those of the compressed air system. There would be a considerable economy of fuel, to be sure, but the saving in this respect would not amount to much on account of the low money price of the coal which is burned under the boilers at a coal mining plant. The fixed charges, however, would be very much reduced, and as shown above, there would be an initial saving of \$8,703, exclusive of the difference in the cost of the boiler plants.

A comparison of the following quotations respectively from the article appearing in the "Colliery Engineer and Metal Miner,"

of May, 1896, and from Mr. Bowden's paper of August, 1900, is very interesting.

"The capacity of the compressor is 296 cu. ft. of free air per minute compressed to 600 pounds per sq. in. with the compressor running at 100 revolutions. As this quantity is more than sufficient for two (2) locomotives the compressor is operated at an average speed of 40 R. P. M., the speed being controlled by an automatic regulating valve, which allows a speed which is sufficient to maintain the required pressure in the air mains."

"Indicated H. P. at 131 revolutions of compressor * * 150 H. P.

"The capacity of the shaft motor is equal to fully double its present work, and the slope motor is working at but about one-third of its capacity (admitted), while the compressor is doing all that it can (obviously, considering the 31 per cent. increase above rated speed of 100 revolutions), and a second one was ordered April 7, 1900."

It would seem very reasonable to conclude that the original expectations had not been realized, as far as the compressor is concerned.

Referring to the latter part of the article, it is easily understood that if air could be compressed and expanded isothermally the most serious losses in the compressed-air haulage system would be eliminated. By the use of water-jackets, etc., we may approach isothermal compression, and, theoretically at least, isothermal expansion can be secured by heating the air in the cylinder. If 50% can be gained by heating the air before it enters the cylinder, i. e., in the auxiliary reservoir, the question arises as to why this was not done instead of purchasing the additional air compressor. Seriously, it is not practical to heat the air on a locomotive, especially a mine locomotive, although reheating has been done in compressed-air traction experiments in Washington and New York. The possibility of gaining 50% by approaching isothermal expansion does not speak well for the efficiency of the system.

[In order that the above discussion may be fully understood, and since Mr. Bowden, who prepared the paper which is used as the basis of Mr. Clarke's figures, has died since his paper was printed, we have submitted Mr. Clarke's figures to Mr. Bowden's successor as chief engineer of the coal companies of the Pennsylvania Railroad Co., Mr. R. Van A. Norris, whose answer is appended.]

Mr. H. H. Stoeck, Editor Mines and Minerals, Scranton, Pa.

DEAR SIR:—I return to you herewith the article "Mine Locomotives, Electricity vs. Compressed Air," by Mr. W. B. Clarke. I have made calculations similar to those made by Mr. Clarke, and believe his conclusions to be practically correct as far as they go. But there are other conditions besides economy which have decided us in favor of compressed-air haulage: the principal ones being the gaseous character of the mines, in which the possible sparking of an electric machine would be a source of grave danger; the simple character of the mechanism of a compressed-air locomotive, which is within the capabilities of a colliery plant to keep in order and repair; the advantage of having a considerable radius of action beyond the charging stations, and the beneficial effect of the air on the ventilation of the mine.

As was shown in Mr. Bowden's paper, the cost of power is but a small fraction of the total cost of operation, the saving for even a 50 per cent. decrease in the steam used being but .09 of a cent. per gross ton mile.

As an evidence of our entire satisfaction with this method of haulage, I might add that we have just ordered another compressed-air haulage plant complete for our No. 1 shaft, Nanticoke, Pa.

Yours very truly,

R. V. NORRIS.
Chief Engineer.

The Cordillera of Mexico.

By O. H. Howarth, F. R. G. S.*

Mexico contains two Cordilleras, or continuous mountain ridges, forming the boundaries between the highlands of the interior and the eastern and western belts of the coast, the Western Cordillera, or Sierra Madre, is the subject of our present notice. It forms a link in the greatest mountain range of the world, which extends, practically, without a break from Alaska to Patagonia, over nearly the half circumference of the earth. The Mexican range possesses features of interest in many respects exceeding those of any other part of the series. It is distinguished by the uniformity in the altitude of the highest ridges, between 10,000 and 11,000 feet. The exceptions are the recent volcanic peaks of Popocatepetl, Ixtaccihuatl, and Colima, on which snow lies perennially on peaks 17,000 feet above the sea.

The general structure of the range is that of a narrow, and very deeply fissured, fold in the earth's surface, the enormous chasms in the central part of the range giving rise to a magnificence of wild scenery unsurpassed in the world. It is not uncommon, in following a trail over the Sierras, to descend as much as 2,000 or 3,000 feet, and reascend to the same or greater heights two or three times in the course of a day's ride down and up these precipitous cañons. As a result of this structure, the erosion of stream beds has, of course, been in a geological sense rapid. All the rivers flowing to the Pacific coast are consequently short in course, and subject, at times, to high and sudden floods. Within my own recollection, at least one small town on

the lowlands, a few miles from the western shores, has been entirely swept away.

Another result of the deep fissuring of the surface within these limits is, that nearly all the mineral veins of the range, from which such vast wealth has been extracted in precious metals from prehistoric ages, are nearly vertical in position. Countless instances are met with of the amazing richness of the mineral products of some of these treasure spots, and almost fabulous as some of them sound, they are borne out by facts in many cases.

I have myself seen a natural globe of solid silver, the size of my head, and many a specimen of ore carrying silver in the proportion of 8,000 to 7,000 ounces per ton. The Cathedral of the City of Chihuahua is said to have been erected at a cost of \$200,000 out of a church tax of three cents per pound weight of silver bullion produced by a single mine in that State.

Most of the highest elevations are thickly covered with pine and mountain oak. For the purpose of supplying mills and other factories with fuel, charcoal is carried 20 to 30 miles on donkeys at an exceedingly low rate.

Animal life is not abundant. There are white-tailed and black-tailed deer, two or three species of antelope, bears, and wild hogs, and jaguars, and some large species of Iguana lizard. Reptiles are few, and the only specimen of a venomous snake, at 5,000 feet altitude, was a small coral snake. Noxious insects are also remarkably few in the mountains. Bird life is likewise by no means abundant. The common buzzard is universal. On the western coast are large flocks of parrots.

The human inhabitants may be designated as the aboriginal, or Indian, population; the modern, or business, population, engaged in mining; and a kind of "odd man out" population of waifs and strays from all parts.

The Mexican is characterized by what may be termed his hereditary poverty, his placid acceptance of all sorts of adverse conditions of life without the slightest effort to remedy them.

ADDRESS OF WELCOME

To the Western Pennsylvania Central Mining Institute, at Johnstown, Pennsylvania, by Hon. John Fulton.

Gentlemen:—

I have been given the very pleasant privilege of extending to the members and visitors of the Western Pennsylvania Central Mining Institute, a cordial welcome to the City of Johnstown. I desire to emphasize the sincerity of this welcome. It is not the usual stereotyped formula of such occasions, but the earnest and truthful expression of hearty warmth of welcome, extended to these distinguished visitors.

Nor have the events of a few years ago been forgotten; when the needs of this Flood City appealed so strongly for sympathy and helpfulness; then Western Pennsylvania came promptly to its relief in that broad and full hearted and handed way, that impressed us all so gratefully.

We not only welcome you, but we desire to do all that we can to make your visit not only pleasant, but profitable as well.

It is in order to congratulate your Institute on this evidence of its onward progress, as it has evidently taken in the inspiration of the "expansion movement". In the past years I understood that its sessions were confined mainly to the really great industrial City of Pittsburg, but this movement of expansion to the modest duplicate of Pittsburg in the City of Johnstown, can be regarded as several steps in advance of its previous operations.

This broadening movement of your Institute is an evidence of health and growth, in the very willingness of extending its usefulness throughout the limit of Western Pennsylvania.

I trust this expansion movement will not be restrained by any fear of that specter of "Imperialism," which has followed in the wake of our National "expansion."

I may be permitted to point out that this Institute is composed of two cooperative sections of practical workers, this crystallization of effort is the modern result of all applied sciences. First, the engineering element. They are and should be the originators and designers of the plans for successful mining or metallurgical operations.

In the department of mine engineering it is now quite evident that a fair grasp of structural geology is one of the prime essentials of the mining engineer. Without, at least an approximate knowledge of the structure of the strata in which valuable minerals are deposited with the associated formation, it is difficult to understand how any safe and economical mining plan can be formulated. The power and efficiency of the mining engineer are embraced in the right diagnosis, if I may be permitted the word, of the mineral deposits, which he is required to the develop. Now, not only structural geology, but all the divisions of this science of geology demand a basis of facts, eliminating

* Extract from a paper in the Scottish Geographical Magazine.

optimism from undetermined data, and rigidly adhering to ascertained data, as the only basis for scientific conclusions.

I am quite sure that my professional brethren in the division of mine engineering will appreciate the importance of thorough investigation in determining the value of mineral properties or in formulating plans for securing the treasures deposited in them.

Behind all science lies the bedrock of the mining engineer, moral character. If the man is not earnest and truthful, he can never secure the confidence of those requiring his services, no matter how ample his scientific attainments.

As drawing is the language of design, the mining engineer should be a moderately good draftsman. By this method alone, he can communicate his knowledge to others to enable them to appreciate values or to develop the minerals. Don't aim, however, to become too expert a draftsman or else you will be kept at the drafting board all of your life and not allowed to get beyond it.

It is also self-evident that the mining engineer should appreciate the value of the application of improved methods of machinery in mining economies, as well as the market or industrial requirements of the same products of the mine. We are living in an age of rapid and marvelous progress in all branches of the industrial arts, and especially in mining; from the immense demands upon its products, it is well to the front of all these movements, and must continue in advance in future progress.

The second or executive division of your Institute, as I understand it, consists of mine superintendents and managers of mines.

Under the law of the division of labor, now clearly developed, these practical men should not only be well up in the lines of the mining engineer, but should possess executive ability of a high order to secure eminent success. The mine superintendent requires to be equipped in a double condition as he has to secure the confidence of his employer and the workmen. He requires that peculiar gift which the Scotch call "gumption" and the Americans "tact," to fulfill in a satisfactory manner this dual office of superintendent.

Of course, as with the mining engineer, character is the same basis of success. Like *Cæsar's* wife, he must be "above suspicion."

But an additional requirement confronts the mining superintendent or manager, the care of the health and lives of the workmen under his employ.

In addition to the clear legally defined duties of their office, and back of all, should be cultivated the kindly sympathetic helpfulness that is so valuable and kindly appreciated by the employees.

In conclusion, we may be permitted to glance at the outlook. If some of the sleeping ones of the eighteenth century could be called up to witness the achievements of the nineteenth, what surprises would await them. The eighteenth century depended mainly on animal power, the nineteenth has the locomotive, the trolley car, the automobile, and the bicycle. The typewriter has displaced the old time quill, as well as the more modern steel pens.

The scythe and cradle have been retired by the mower, and reaper, and binder; the rush lights and tallow dips are succeeded by the rock oil and arc light; the galvanic battery has been succeeded by the powerful dynamo; in war, the old match and flint locks are appliances of the past, and are succeeded by the most wonderful variety of rapid-firing and long-distance killing implements of war; the "wooden walls of England" have been displaced by the steel-walled ships of the nineteenth century; the ancient beacon or signal fires have been succeeded by the telegraph, the telephone, and the wireless or aerial telegraph. The first appearance of the Hudson River front to a visitor to New York City impresses prominently the presence of the twenty storied "sky scrapers" of steel over-topping the old-time structures.

But in this astounding rate of progress, with its immense demands for material, the important question of the continuity of the sources of supply of the crude material for the manufacture of the pig iron with its present output aggregating 13,789,242 gross tons during the past year, confronts us. Just here we are cautioned to avoid the danger line of prophetic utterance, as we are reminded that the days of the true prophet have long since passed away, a fact that does not appear to have general acceptance, as we have many false prophets in our day.

In the mineral fuel department it may be submitted that as far as investigation has disclosed we have in the United States at least 250,000 square miles of coal measures surmounting the aggregate of all the other nations of the world. With all this extent of beds of mineral fuel, this inquiry is anxiously urgent, how long can we sustain our great annual consumption of coal, now in round numbers 254 millions of tons?

Can we continue to manufacture 20 millions of tons of coke per year, with the Connelleville exhausting its great coking coal area by contributing 10 to 12 millions of tons of coke? Can the iron ore mines of Michigan, Minnesota, and other regions, long sustain the large annual output of 26 millions of tons?

We have been favored with answers to these questions by the

optimistic and pessimistic schools of these prophets; these predictions disturb no thinking persons, when it is considered that the future as well as the past is in the omniscient mind and direction of the Creator of all. It would be an impeachment of His infinite wisdom to entertain the thought, that in the material resources for the use and well-being of man, the Creator has failed to provide for all these conditions throughout all time. In our limited visions we cannot see the order of succession or replacement of these supplies and forces.

The great northern zone of the United States and Canada await exploitation for the ores of iron. The Mesabi and Vermilion ranges are not the final terminals of our iron ore supply. In view of all these facts, it would be puerile to worry about the future; but rather in the contemplation of the steps in the progress of industrial movements in the past, feel fully assured that as these have come to us in progressive instalments, just as we needed their advents, so in the future, under similar laws, we can confidently expect all needed supplies for our upward progress until the Infinite One shall announce, that time shall be no more.

Coal Mining Under Sydney Harbor, New South Wales.

Mr. J. L. C. Rae gives the following account of the discovery of coal under Sydney Harbor, New South Wales, in a recent issue of the *New Zealand Mine Record*:

It seems that in 1847, an unprofessional geologist, the late Rev. W. B. Clarke, believed in the existence of coal underneath Sydney, and showed before a committee of the Legislative Council that taking a dip of one degree from New Castle to the south and Illawarra to the north, the synclinal curve would meet at the entrance to Broken Bay, and by his calculations, at a depth of 4,680 feet the coal seams, if continuous, would be found. Again, in 1850, the same gentleman referred to the probable existence of coal under Sydney and the possibility of mining for coal under the harbor itself. In 1866, a professional man, Mr. J. MacKenzie, late examiner of coal fields, took up the subject and referred again to the probable existence of coal under Sydney. The thing was from time to time discussed by local geologists and engineers, but not till 1878 was any real attempt made to verify the assumptions made. Then several bores were put down at different times for a depth of between 1,000 and 2,000 feet, without success, yet without cause for fatal discouragement. At last, in 1890, coal was successfully reached at depths varying from 1,500 to 2,500 feet. The coal was found to vary in thickness, an upper seam in one place being 4 feet 8½ inches, and a lower seam 6 feet; in another place 4 feet 2 inches, and 5 feet 3 inches. In yet another place three seams of coal were struck, severally 1 foot 5 inches, 1 foot 4 inches, and 6 feet 6½ inches. This last was at a depth of 2,507 feet, the total depth bored was 2,601 feet. These results proved conclusively that the town of Sydney, at least, was underlain by workable seams of coal, and if so, there was every reason to believe the adjacent harbor was likewise. Two able geologists, one in the employ of the Government and the other a professor of geology at the University, devoted much attention to the subject, and predicted, with wonderful accuracy, the depth at which coal would be found under Sydney.

In 1890, a syndicate undertook the task of finding coal under Sydney Harbor. The first bore was located on land close to the harbor and 54 feet above it; it was carried down to a depth of 3,005 feet from the surface. At 2,801 feet a coal seam 7 feet 3 inches thick was found partly converted into coke by the intrusion of two volcanic dikes. The dikes were subsequently traced to the surface and the site of the next bore by the careful selection of two eminent geologists (the syndicate having wisely applied for a geological survey of the neighborhood to determine the trend of the dikes) avoided them. The diameter of the bore was 5 inches to a depth of 2,400 feet and thence downward it was 4 inches. On the 8th of November, 1893, at 2,917 feet, the top of the Butte coal seam was struck, and after 24 hours of continuous boring, lowering and raising of rods and core barrel, the seam of coal, 10 feet 3 inches, was bored through. The total depth of the bore was 2,929 feet.

The coals are described as good household coals and excellent steam coals, yielding an excellent coke. The analysis of samples taken up in the drill hole were as follows:

	Per Cent.
Hygroscopic moisture	0.66
Volatile hydrocarbons	17.57
Fixed carbon	71.09
Ash	10.68
Coke	81.77
Mean percentage of sulphur	0.724
Mean specific gravity	1.346
Mean calorimetric value	13,000

The syndicate is now called the "Sydney Harbor Collieries, (Limited)." The authorities to mine now extend over an area of 10,167 acres, and it is estimated that the quantity of coal available for working will be about 113,000,000 tons.

THUNDER MOUNTAIN, IDAHO.

A Mining Region About Which Little Is Known, but Which Promises Great Richness.

Written for MINES AND MINERALS, by Wm. E. L'Hame.

Although much is known concerning the mineral wealth of Idaho, there still remain portions practically unknown to the outside world. These lie almost in the central section of the State, and their retarded development is due principally to their inaccessibility and remoteness from transportation facilities. Surrounded by a labyrinth of intricate ranges and lofty peaks whose snows are exceedingly deep, entrance to this silent country can rarely be effected before July, and only then with packhorses.

The drainage is mainly through the Middle Fork of Salmon River and its tributaries, and to the uninitiated it would appear as though entrance could best be effected along the main Salmon and lower Middle Fork. But here the traveler is confronted by insurmountable cliffs. For fifteen miles above its junction with the main river, the Middle Fork has carved its bed through solid rock, the work of ages; sheer drops of one thousand feet being frequent while the confining slopes rise from two thousand to three thousand feet higher. A few daring adventurers have braved the dangers of this rapid stream, descending in frail boats and effecting a landing now and then along the narrow bars which yield well to the rocker. The gold is fine and the deposits are of the class known to miners as "skin digging." They are replenished every year, gold being washed in during every flood period. The fact that a pan of gravel can scarcely be picked along this stream without getting the "color" suggests to the intelligent prospector that somewhere above must lie extensive belts of auriferous material awaiting the hand of enterprise.

One of these deposits was discovered about three years ago, a veritable mountain of ore, whose estimated wealth throws the treasures of the Incas into shade. The locality is now known as "Thunder Mountain," and reaches to an elevation of eight thousand feet, occupying a central position among the headwaters of Marble, Holy Terror, and Monumental creeks. The Caswell brothers are the discoverers and owners of this magnificent piece of property, which is a monument to their energy and perseverance. They are of the type that constitutes the pioneers of development and civilization. Untiring in their efforts, and willing to brave the hardships of such a life, these men secluded themselves in the wilderness to be rewarded by the discovery of a deposit whose counterpart will be hard to find in the State. The original discovery was made in a gulch which leads to a low depression near the summit and which showed crystalline gold in appreciable quantity.

The geological structure of Thunder Mountain is both interesting and instructive. It consists entirely of volcanic material, and the manner of occurrence ranges from a simple dyke to a series of sheets surrounding a probably volcanic center or neck. Mineralogically and structurally it is strongly suggestive of the famous Cripple Creek region of Colorado. The predominating rock is rhyolite of a whitish color with porphyritic development of sand in feldspar and quartz crystals, giving it the characteristics of liparite. The gold occurs in this material in native form, auriferous pyrite being found only sparingly, while magnetic iron, a constituent of most volcanic rock, is almost entirely absent. A yellow stain suggests the presence of lead. Overlying this stratum, we find a volcanic breccia whose fragmental constituents bear a close resemblance to the eruptives occurring in association with it. Vesicular basalt caps the breccia and appears exclusively of all other rocks to the north. The rhyolite is intercalated by phonolite intrusions, and it may be that the effect of these eruptives upon the mineralization of the rhyolite plays an important part. To settle this point will require detailed observation in field and laboratory.

Thunder Mountain has already proven a gold producer although its history dates back but three or four years. Its yield is astounding considering the short duration of its working season. During the year of 1899 the Caswell brothers set up a hydraulic plant on a small scale, with low pressure and a water supply that permitted of a run of only four hours at a time. After seventy-two hours of piping, thirty-four pounds of gold were taken from the sluices and it will not be amiss to mention that the appliances for saving this fine gold were extremely primitive. Speaking from personal observation, I do not believe that much over fifty per cent. of the entire gold contents could possibly have remained in the sluices. The tailings show color in every pan, and all rock taken from the dumps will yield the yellow metal in the horn-spoon. During the first season, a point above the present workings was mined by the old-fashioned rocking process and five hundred dollars were taken out in four days. Single pans produced as high as ten dollars, but such was not an average by any

means. The zone of rhyolite exposed by hydraulicking shows a thickness of two hundred feet by about five hundred feet in length. It is impossible to pick a sample on the face of this cliff that will not pan, and yields of fifty cents to one dollar to the pan are quite frequent. The average of this exposure by mill test gave fourteen dollars to the ton, but single strata occur that will go much higher. A lenticular body of dark rhyolite carries values to the tune of two hundred dollars to the ton, and some time ago a similar body was encountered at a lower level whose contents were well in the thousands, the rock being fractured and friable and fairly glistening with gold.

This is by no means the only instance where the rhyolite is productive. The deposit lies horizontally, and about one mile southeast of the original discovery crops out again on the opposite slope of the mountain. Water here is very scarce, and the owners of the claims had to wheel the dirt a quarter of a mile to a little spring, and taking the dirt without selection, would rock out at the rate of one ounce per day to the man. Again, the rhyolitic strata makes its appearance near the head of Holy Terror Gulch, protruding from beneath the breccia and exhibiting its usual characteristics. To the south, the volcanic breccia stretches to considerable extent, and should it determine the position of the auriferous series, the value of this mineral belt could hardly be estimated.

At present, the most feasible route to this new region is by way of Warren, although a new trail has been cut from the south by way of Bear Valley. The trail from Warren leads by the South Fork of Salmon River over Mount Logan, thence along Big Creek to Snowslide Mountain and down Monumental Creek. Evidences of early glaciers are found at many points along the route, and it is probable that their existence was quite general throughout this section of Idaho. On Snowslide Mountain, glacial phenomena are particularly marked and ice action is rife even now in these high altitudes. Near the summit is a lake whose waters are held back by terminal moraines. The heavy deposit of boulders here is derived from the surrounding mountains. A recent stream has cut the canyon below and formed rough slopes, often difficult to traverse. The prevailing rocks are volcanic, basalt and rhyolite predominating. These same conditions prevail along Monumental Creek, which is also a U-shaped canyon whose gentle slopes terminate in bold bluffs above forming an insurmountable wall for many miles.

Generally speaking, this country offers many inducements to the prospector. An abundance of big game, fowl and fish, water and timber for mining purposes and practically virgin ground. Big Creek, Deer Creek, Monumental Creek, Marble Creek, Johnson Creek, and many others show gold in the very top wash, but bed rock in any of these has never been touched by the miner's pick. The amount of auriferous material removed by erosion through these streams is enormous, and it is no more than reasonable to expect a concentration of at least the coarsest gold near the bed rock.

The few prospectors who have visited this region so far have failed to find fortunes on top of the ground and consequently nothing further has been attempted. I think that the chances for the existence of valuable placer ground are exceedingly promising, and since the discovery of auriferous rock in place, the country will no doubt meet with an experience which will prove its possibilities as a gold producer.

Coal Mining in Belgium.

The number of mines in operation in 1899 was 120, as compared with 119 in 1898, 117 in 1897, 121 in 1896, 123 in 1895, and 123 in 1894. The number of pits in working in 1899 was 236, as compared with 258 in 1898, 256 in 1897, 262 in 1896, 264 in 1895, and 262 in 1894. The number of pits in course of development was 14, as compared with 5 in 1898, 7 in 1897, 9 in 1896, 8 in 1895, and 12 in 1894. The production was 21,572,000 tons as compared with 22,043,000 tons in 1898, 21,513,000 tons in 1897, 21,252,000 tons in 1896, 20,458,000 tons in 1895, and 20,535,000 tons in 1894. The imports of coal into Belgium in 1899 were 2,844,000 tons, as compared with 2,203,000 tons in 1898, 2,017,000 tons in 1897, 1,693,000 tons in 1896, 1,530,000 in 1895, and 4,540,000 tons in 1894. The exports of coal from Belgium were 4,569,000 tons, as compared with 4,580,000 tons in 1898, 4,449,000 tons in 1897, 4,650,000 tons in 1896, 4,661,000 tons in 1895, and 4,540,000 tons in 1894. The consumption of coal in Belgium accordingly amounted to 19,002,000 tons, as compared with 18,452,000 tons in 1898; 17,638,000 tons in 1897, 17,063,000 in 1896, 16,225,000 tons in 1895, and 16,107,000 tons in 1894. The average profit realized in 1899 was 34 cts. per ton, as compared with 21 cts. per ton in 1898; 18 cts. per ton in 1897, 104 cts. per ton in 1896, 8 cts. per ton in 1895, and 8 cts. per ton in 1894. It will be seen that Belgian coal mining has become a much more profitable business of late. The aggregate value of the coal raised in 1899 was estimated at \$54,875,000; the amount paid in wages was \$29,170,000, and the profit realized for the year

was 9,480,000. The increase in the value of the production in 1897 as compared with 1896 was \$3,625,356, of which \$1,655,935 remained in hand as so much additional profit. The value of the coal raised in 1898 showed an increase of \$4,328,806, as compared with 1897, of which \$724,246 remained in hand as so much additional profit. The increase in the value of the coal raised in 1899 was \$6,145,940 as compared with 1898, of which \$2,837,963 remained in hand as so much additional profit. The increase in the value of the coal raised during the three years, 1897, 1898, 1899, was accordingly \$14,110,104. The increase in the wages paid in the same period was \$5,696,059; the increase in other expenses was \$3,164,876; and the increase in the profits realized was \$5,249,119.

MINE SURVEYING PROBLEMS.

Methods Used in Solving Them Under Peculiar Conditions in The Zinc-Lead Regions of Missouri.

Written for MINES AND MINERALS, by W. E. Gordon.

Nowhere are more special problems presented to the mine surveyor than in the Southwest Missouri lead and zinc region.

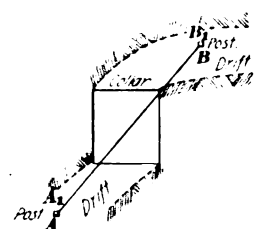


FIG. 1.

Here coyoting or gophering is carried to the extreme. The causes are the small size of mining lots, the small capital of the lessee, and the desire for a quick return and large output while ore is high. These workings are abandoned, and when the ground is drained by the working and pumping of lower levels, a call is made upon some surveyor to plat the abandoned workings so that they can be reached from other shafts or to sink new shafts to reach the same ore. The problems given in this paper are three. Fig. 1 shows a small shaft which has no other opening. I set two posts in the ground, A and B , and from their tops suspend two plumb-lines connected at D and E by a cross-tie so that they will swing clear of the walls of the shaft. At the top of the drift another cross-tie $F'G$ connects the plumb-lines, and at H and I they are separated

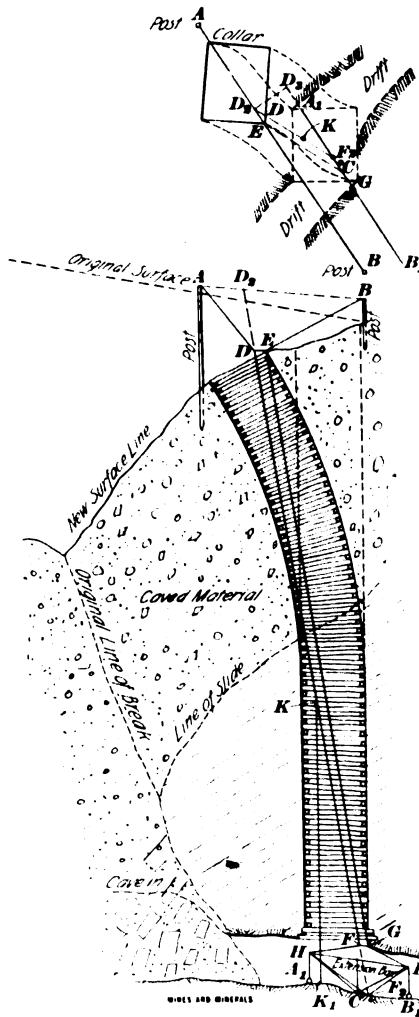


FIG. 3.

by an extension bar of light pine, and from H and I the plumb-lines are continued down and terminate in two heavy plumb-bobs of equal weight. This gives an extended base on the surface, submits to the contracted conditions in the shaft, and then extends to a base line of convenient length when reaching the drift. The weight of the plumb-bobs causes AB , HI , A_1B_1 , to assume positions in the same vertical plane. If the extension bar has a slight curve downward, it will swing its center of gravity in this plane, and cause the minimum error possible. Having tacked two hubs or lined a transit with both plumbs, disconnect the extension bar and lower tie, and plumb direct. This will give the projection of the points D and E , on the base line, and also a check on the previous operation. Having set up the transit, take notes as in ordinary work, checking again on the base at the close.

Fig. 2 shows a case in which the collar has caved in and a pile of gob is at the foot of the shaft. The caved material is in the way of any check, so the transit has to be set in line with the two plumbs and the base produced in the drift, if possible. Then disconnect the extension bar HI and lower tie FG , and get the distance from the nearest plumb to the center of the instrument. At the close of survey, check on base line again. In this case, no improvement was contemplated. The only problem was to locate ore bodies that could be reached by a new shaft.

Fig. 3 illustrates a case where a cave in the former workings had extended to the surface, followed by a slide of the ground surrounding the shaft. The timbering was of 5-inch poles, new at the time the cave-in occurred, and laced with green hickory poles and elm plank. The ground had settled until no further cave could be looked for, and the shaft, while intact, was in such a shape that no part of the collar was vertically over the lower half of the shaft. It was desired to locate an ore body so that a tunnel could be driven to it from an adjoining shaft.

The principle used in this work was to pass a plane through three points by connecting two lines at A and B , then connecting them at D and E , and connecting them again at F and G , extending them to H and I , and then connecting and anchoring them at C , with as great a tension as the lines will stand. The lengths HC and CI are taken so that the vertical plane passing through C and the middle point of HI will be at right angles with a vertical plane passing through H and I . This will reduce the disturbing effect of gravity on the extension bar to a minimum.

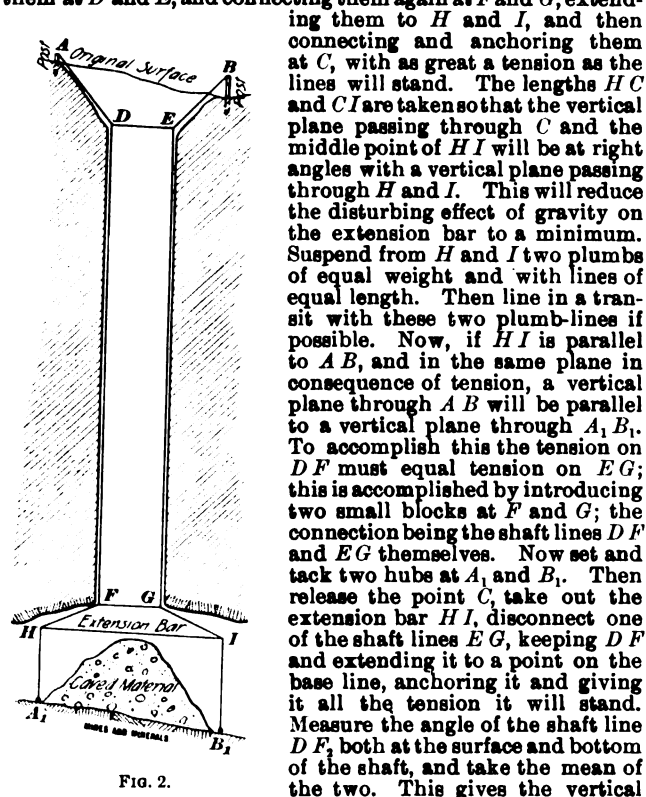


FIG. 2.

Suspend from H and I two plumbs of equal weight and with lines of equal length. Then line in a transit with these two plumb-lines if possible. Now, if HI is parallel to AB , and in the same plane in consequence of tension, a vertical plane through AB will be parallel to a vertical plane through A_1B_1 . To accomplish this the tension on DF must equal tension on EG ; this is accomplished by introducing two small blocks at F and G ; the connection being the shaft lines DF and EG themselves. Now set and tack two hubs at A and B . Then release the point C , take out the extension bar HI , disconnect one of the shaft lines EG , keeping DF and extending it to a point on the base line, anchoring it and giving it all the tension it will stand. Measure the angle of the shaft line DF , both at the surface and bottom of the shaft, and take the mean of the two. This gives the vertical angle. Now, from a point on this tension line, DF , suspend from K another plumb-line and get the point K_1 . Measure the angle $K_1F_1A_1$. Measure the distance D_1F_1 . This line being within a few degrees of vertical, the distance between the parallels can now be computed very closely and the point F_1 determined. The distance D_1F_1 multiplied the cosine of the angle D_1F_1 makes with the horizon, gives the horizontal projection of D_1F_1 . Having the angle $K_1F_1A_1$, multiply the distance obtained in the last operation by the sine of this angle. This will give the horizontal distance apart of the base, and the auxiliary base in the ground at the shaft bottom. Multiply the horizontal projection of D_1F_1 by the cosine of the angle $K_1F_1A_1$, and the point D_2 is obtained by measuring the base line, or base line produced by laying off

the distance F, D , obtained in the last operation. Now make the survey as in the other cases, checking on the base line at the close. In the case referred to, the error was found to be only three minutes when the tunnel was driven to the ore body, and opened so as to use the old shaft for ventilation.

Practical Economy for Steam Users.

No argument is needed to convince the intelligent owner, engineer, or fireman that the continuous feeding of water to a steam boiler, at exactly the same rate that it is evaporated, means a heavy saving of fuel.

The Clark regulator alarm column shown herewith is said to regulate the feedwater so that there is no perceptible variation in the water level in the boiler because of the water being replenished fast or slow.

Among the advantages of an automatic regulator are the following: It is always on duty and it never sleeps or tires; it never forgets; in all these respects it has the advantage over a man, who, no matter how faithful he may be, is still human and liable to mistakes. The time saved by the use of a Clark regulator alarm column permits the engineer or fireman to give more attention and care to minor repairs and other essential work about the boiler room.

Steam boilers are designed to carry a certain height of water and with the water always where the maker of the boiler meant it to be, the life of the boiler is undoubtedly prolonged and repair bills reduced. Again, it is self-evident that the boiler feed pump running continuously at slow speed will last longer and require less repairs than a pump worked to its full speed intermittently. The Clark regulator alarm column permits the former economic method. In connection with the regulator alarm here described

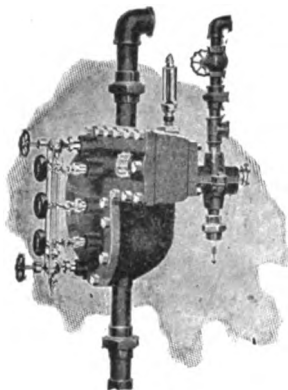


FIG. 1.

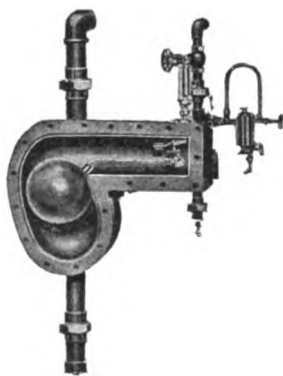


FIG. 2.

is a low-water alarm which sounds if the pump fails to replenish the water, or if for any reason the water falls below its normal height. Such low-water alarms are required by law in a number of States and their value is recognized by every careful steam boiler owner.

The action of this regulator alarm column is shown in Fig. 2. It acts positively under all variations of steam pressure and the long float arm renders its inoperation impossible. As is shown by the sectional view, the regulator does not contain a weight, spring, stuffingbox, connection, or joint. The valve is of the rotary balance type and is a continuation of the mandrel, to which the float arm is attached. The valve is perfectly balanced in all directions, with friction reduced to the minimum and wearing surfaces dispensed with entirely. The valve is self-cleaning, and no matter how heavily charged the water may be with lime, or other chemicals, it cannot clog up or interfere with its workings.

The trimmings furnished with each alarm are of good quality and workmanship and the alarm whistle is capable of sounding an alarm which can be heard throughout all parts of a plant. This alarm column is attached exactly the same as an ordinary water column, and the same rules govern its use and attachment.

To replace an ordinary water column with the Clark it is only necessary to take the old column down, place the Clark in its place, then pass a steam line from the boiler to the pump through the valve on the column. Any engineer or fireman who knows how to put pipe together can do the work.

The method of operation of the column is as follows: Set a valve (the regulator) in the steam line between the boiler and the feed pump. That valve being actuated directly by the water in the boiler through the medium of the float in the float chamber of the regulator alarm column, if the water falls $\frac{1}{2}$ of an inch in the boiler, the valve is correspondingly opened, and the

pump slowly started. As the water raises the valve is closed, so we find the valve adjusting itself to the load.

These columns are made in five sizes for boilers ranging from 20 to 600 H. P., the catalogue prices for the same varying from \$30 to \$80.

In addition to the regulator alarm column, the Clark Co. also manufactures an alarm column which is simply a low-water alarm. It is not designed to save fuel or time and is merely designed to sound an alarm when the water reaches a danger point. Its method of action is very similar to the regulator alarm column and it is made with the same care in design. It is also made in six sizes varying in price from \$20 to \$26. The Clark Bros. Co., of Vicksburg, Mich., issue a very neat and well-gotten-up circular entitled "Practical Economy for Steam Users," descriptive of the two devices given above and also containing in addition useful information upon the care of boilers. Write to the manufacturers for a copy of this pamphlet, mentioning MINES AND MINERALS.

Yoch Coal-Mining Machine.

The Belleville Pump and Skein Works, of Belleville, Ill., has recently acquired all of the rights, patents, and title for the United States and foreign countries to manufacture and sell the Yoch mining machine. These machines have been manufactured by the same concern since 1882, so that the company is not going into an untried business, but one which it has proven itself fully competent to handle.

The Yoch machine is already well known, but so many improvements have been made in it recently by the manufacturers that the machine is in many respects a new one and a description of it will therefore be of interest, particularly since the construction and even the appearance of the machine have been radically changed. The makers claim for this machine that it will produce a very large amount of undercut per hour and that it will accomplish this result with a very small amount of air, and at a small labor cost.

The machine is made of best selected material and great care is taken in manufacturing it. All of the parts are interchangeable, thus assuring the purchaser that there will be no delay in securing duplicate parts. As the manufacturers of the machine have their works in the center of a mining district, they have the advantage of being able to follow the machine closely under working conditions. The machines are built of such weight as to allow high pressure to be applied to the piston so that it will strike a strong and vigorous blow. It cushions on imprisoned air and does not therefore need metallic or leather buffers. The piston is easy of access for packing similarly to an ordinary stationary engine or pump. The piston head can easily be removed for repairs. The pick holder extension is made of 3½-inch hammered crucible steel and has taper sockets for both rod and picks so that no keys are required. The main valve is operated by an independent engine which produces a uniform stroke and gives economy in the working of the machine. The machine cuts off at $\frac{1}{2}$ stroke the remaining $\frac{1}{2}$ being due to expansion, thus giving a saving in power used. A pressure of 60 to 100 lb. is carried and this is controlled by a patent regulator, which does away with the necessity of closing the throttle valve between the pipe or hose and the machine, and permits it to remain open until the machine is ready to be moved. A patent lubricator permits an economy in the use of oil and gives very efficient oiling, as it permits the oil to be carried with the current of air and thus thoroughly oils the entire inside of the machine.

These machines have an adjustable center to suit the ideas of different operators and different lengths of picks. The machine undercuts 6 feet.

The Belleville Pump and Skein Works court inquiry of the machine and will be very glad to furnish further information to those addressing them at Belleville, Ill., and who refer to MINES AND MINERALS.

A Business Proposition.

Alexander McGregor, who is interested in asphaltum beds situated about thirty miles from Rifle, Col., has made a proposition to the council of that city in which he offers to give all the asphaltum necessary to pave Union avenue from the viaduct to the central block, the city to pay for the mining of the material, the freight and the expense of laying it.

While this is not a proposition that should be made to every community, it is undoubtedly one of the best methods of advertising that Mr. McGregor could have selected and if successfully carried out will yield him large returns for the money invested. Other industries have tried the same plan and have been eminently satisfied with the results. Brick paving was advocated in much this way and has reaped its reward.

SUMMER MEETING

Of the Western Pennsylvania Central Mining Institute at Johnstown, Pa., June 11 and 12, 1901.

The summer meeting of the Western Pennsylvania Central Mining Institute held in Johnstown, Pa., Tuesday and Wednesday, June 11 and 12, 1901, was undoubtedly one of the most successful, if not the most successful meeting of this Institute ever held. There was an unusually large attendance, which would have been even larger, but for the accident at Port Royal, Pa., which kept a number of the mine inspectors away from the meeting, and also undoubtedly detained a great many of the mine officials from the same locality.

Through the courtesy of the officers of the Carnegie Library, the meetings were held in the assembly room of the library, just across the street from the main offices of the Cambria Steel Co., and near to the Pennsylvania Railroad station and to the leading hotels of the city. The official headquarters were at the Merchants Hotel, but owing to the fact that there was an unusually large number of strangers in Johnstown at the time of the meeting, only a portion of the members of the Institute could find accommodations at the Merchants, and the others were, therefore, compelled to distribute themselves among the other hotels of the city.

The first session of the Institute convened at 10:30 A. M., on Tuesday, June 11, with President T. B. De Armit in the chair, and Secretary James Blick at the secretary's desk. On behalf of the citizens of Johnstown, the Hon. John Fulton extended a most cordial address of welcome to the members of the Institute, following the address of welcome by an able paper upon the qualifications of mining officials and the future of the mining industry. This address is printed in the present issue of MINES AND MINERALS.

President De Armit replied very felicitously to Mr. Fulton's address of welcome, and in his reply laid stress upon the fact that the name of Fulton was synonymous with development in the iron, steel, coal, and coke industries. He also very wittily referred to the fact that nearly every one thought of our place of meeting as being literally "John's town," from the fact that the name of John Fulton was so intimately connected with the history of Johnstown. President De Armit thanked Mr. Fulton for his cordial welcome and Mr. Josiah Evans, mine inspector, of Johnstown, who was the local committee, and to whose efforts the success of the meeting was largely due. He further stated that at the meeting of the Institute held in Pittsburgh, December, 1900, it had been suggested by Mr. Brownlee, formerly Chief of the Bureau of Mines, that a meeting held further east than Pittsburgh would be beneficial to the interests of the Institute, as it would enable mining men outside of the immediate vicinity of Pittsburgh to become acquainted with the work and plans of the Institute. This suggestion of Mr. Brownlee was taken up by the winter meeting of the Institute, and as soon as it was decided upon holding the next meeting outside of Pittsburgh, Mr. Josiah Evans wanted to know, "What's the matter with Johnstown." As a result of this pointed question and suggestion, the meeting was being held in Johnstown, and the attendance at the meeting showed that the choice of place was a very wise one. Mr. De Armit then extended a most cordial welcome to all mining men present, and particularly those of central Pennsylvania, to participate in the meetings of the Institute and to become members of it. He stated further that the main object of the Institute was that its members might be instructed by papers such as had been given by Mr. Fulton in his very cordial address of welcome.

In response to the invitation of President De Armit, at least fifty new members were added to the roll of the Institute. By unanimous vote the Hon. John Fulton was elected an honorary member, after which the first session adjourned.

The session Tuesday afternoon consisted of a visit to the Rolling Mill Mine of the Cambria Steel Co., this visit being made possible through the courtesy of the officials of this company, and particularly to Mining Engineer Marshall Moore, who had made elaborate preparations for the comfort of the party, and who accompanied the excursion, explaining fully all the details connected with the work of the mines. The Rolling Mill Mine is one of the oldest and largest mines in Pennsylvania, having been operated for a period of over fifty years. It is entered by a single-track drift, and for the first 8,000 feet the haulage is carried on by means of a tail-rope system. From the end of this haulage system throughout the rest of the mine, haulage is carried on by means of compressed-air locomotives. The trip through the mine was made in mine cars, which had been provided with seats, and between 2 o'clock and 6 over seven miles of gangway were traversed. After traveling over three miles underground a shaft was reached by which the party climbed to the surface

and inspected the air-compressor plant which supplied power for the compressed-air locomotives and for the mining machines, all of which were operated by compressed air. This air-compressor plant is undoubtedly one of the finest in the United States, and is probably the most elaborate and extensive plant connected with any coal mine in the United States. As it is hoped to give a complete description at some future time, a detailed description will be omitted in connection with this account of the Institute meeting. One very novel feature, however, is of interest. Provision has been made so that in case of fire in the mine, pumps can be connected with the compressed-air pipe and water carried through them to any part of the mine.

The session Tuesday evening convened at 8 P. M., with Mr. Josiah Evans in the chair, owing to the temporary absence of President De Armit, who, however, soon took the chair. The names of those who had joined and paid dues in the morning were read by the secretary for the purpose of verification. Cards were then distributed to all of those present upon which the names, addresses, and official positions were recorded.

The first paper of the evening was read by Mr. M. G. Moore, mining engineer of the Cambria Steel Co., upon the subject of "Mine Cars." This paper was discussed at length, and both the paper and discussion will appear in the August issue of MINES AND MINERALS. The second paper of the evening was upon the subject of "Longwall Mining," presented by Mr. Clarence Claghorn, mining engineer of the Lackawanna Iron & Steel Co., Vintondale, Pa. The animated discussion which took place upon this paper was not only a tribute to the value of the paper, but also showed that it was a subject in which the members of the Institute were greatly interested, and which will undoubtedly, therefore, serve as a subject for discussion for subsequent meetings of the Institute. This paper and discussion will also appear in the August issue of MINES AND MINERALS.

The Institute passed a vote of thanks both to Mr. Moore and Mr. Claghorn for their very able and interesting papers. The secretary was also authorized to convey to the directors of the Carnegie Library the appreciation of the Institute of their courtesy in permitting the Institute to make use of the Library Hall free of charge. The Institute also voted its appreciation of the arrangements made for its comfort by Mr. Evans.

At 8 o'clock Wednesday morning about one hundred members of the Institute took a special train on the Pennsylvania Railroad for Windber. Here they were met by Mr. James Cunningham, superintendent and mining engineer of the Berwind-White Coal Mining Co., and other officials of this company, under whose guidance this modern and up-to-date plant was thoroughly inspected. As descriptions of various portions of this plant have appeared in MINES AND MINERALS from time to time, it will not be necessary to go into details, but the reader is referred to the issue of February, 1898, for an account of the Capell fans used for ventilating the mine; to the issues of September, 1899, October, 1900, for accounts of the electrical system used for electric haulage, and to the issue of March, 1901, for an account of the system of mining in vogue. The reading of these articles will give a person a very excellent idea of this plant, which is undoubtedly one of the best equipped coal-mining plants in the United States. The company has at present time in Windber and immediate vicinity ten openings, each of which is designed for an output of 2,000 tons per day, and each plant is practically complete in itself. These mines are peculiar from the fact that there are no mules used in connection with the haulage, which is entirely carried on by electricity, and there are no diggers, as the mining is all done by compressed-air punching machines.

Through the courtesy of the Berwind-White Coal Mining Co., dinner was served to the members of the Institute at the various hotels of the city, after which the party broke up into smaller sections and visited points of interest about the town, and the mines in the immediate vicinity. Three years ago the writer visited Windber, or, as it was then called, Scalp Level, and where there is now a town of from 7,000 to 10,000 people, there was at that time one office building. Windber is up to date in every particular, and has all the appearance of a thriving mining town in the Far West. It will soon have paved streets, trolley line, and all the other modern improvements. One very pleasant feature of the stay in Windber was the presence of the local band, which turned out to welcome the Institute, and which escorted it about from place to place. At 3 o'clock the special train left for Johnstown, and at South Fork those who were going east left the special and took the regular trains on the Pennsylvania Railroad, while those who were going through to Pittsburgh, took the through trains from the same point. The officers of the Institute and the members of the local committee are to be congratulated on the success of the meeting, and the experiment of holding at least a part of the meetings away from Pittsburgh was so successful in this instance that no hesitancy should be felt in repeating the experiment at some future time.

Following is a list of some of those who attended the meeting:

PENNSYLVANIA.

Altoona.—C. F. Fraser, Mining Engineer; R. Hampson, Mine Inspector 12th District; Jos. J. Silliman, Mining Engineer; Jas. Williams, Mine Inspector 10th District.
Baird.—Thos. Hall, Mine Foreman, Shoenberger Coal Co.
Barnesboro.—Wm. Crickton, Mine Foreman.
Beaver Falls.—J. B. Williams, Mine Foreman, R. F. No. 3.
Brownsville.—Christopher Bakewell, Coal Operator; William Seddon, Mine Superintendent.
Carrolltown.—Richard C. Morris, Mine Superintendent.
Conemaugh.—J. A. Buck, Assistant Superintendent; John Donaldson, Mine Foreman.
Dubois.—Jos. Bailey, Superintendent North western Mining & Exchange Co.; Elias Phillips, Mine Inspector, 4th Bituminous District.
Dundo.—Joseph Appleyard, Mine Foreman; Jas. S. Campbell, Superintendent Henrietta Shaft; Thos. Griffiths, Mine Superintendent.
Dunbar.—J. W. Greaves.
Edgewood Park.—B. H. Taylor, Mining Engineer.
Edri.—A. M. Oliver.
Ehrenfeld.—Wm. Leckie, Superintendent.
Friedens.—J. H. Lane, Superintendent Wells Creek Coal Co., Ltd.
Glen Glade.—Thos. H. Booth, Mine Foreman.
Goff P. O..—John McDonald, Foreman Donohoe Coke Co.
Greensburg.—H. C. Burket, Superintendent Atlantic Crushed Coke Co. and Johnston Coal Co.; David Clark, Alex. Coulter, Coal Operator; G. W. Hutchinson, Mining Engineer; Geo. E. Loughner, Robert Morris; C. B. Ross, Mine Inspector 2d Bituminous District; I. G. Roby, Mine Inspector, 5th Bituminous District; J. D. Wendling, Superintendent Carbon Coal Co.
Haser.—Henry Harris, Mine Foreman; J. H. Powell, Superintendent.
Hastings.—John D. Jones; Chas. Stewart; James Campbell, Superintendent.
Houtzdale.—W. R. Cameron, Assistant Superintendent for Berwind-White Coal Mining Co.
Ilwaco.—James Blick, Mine Inspector 7th Bituminous District.
Ingram.—L. J. Daft, of the Ingersoll-Sergeant Drill Co., of Cleveland, Ohio.
Jennette.—William Clifford, Builder of Mine Fans.
Johnstown.—Edward C. H. Bantel, Assistant Engineer M. & S. Dept., Cambria Steel Co.; James Brownlee, Mine Foreman; James M. Cook, Jr., Assistant Engineer M. & S. Dept., Cambria Steel Co.; Charles E. Curtis, Civil Engineer Cambria Steel Co.; John Daniel, Mine Foreman; Ulysses Daniels, Motorman; Josiah Evans, Mine Inspector 6th Bituminous District; John Fulton, Mining Engineer; John T. Harris; Charles L. Hower, Civil Engineer Cambria Steel Co.; Rev. Oliver James; John Jones, Assistant Mine Surveyor; H. M. Malcolm, Miner; M. G. Moore, Mining Engineer Cambria Steel Co.; George W. Morris, Machine Boss; William H. Morris, Superintendent Merchants Coal Co.; J. P. Powell, Fire Boss; Jonathan Powell, Fire Boss; George T. Robinson, Superintendent of Mines, Cambria Steel Co.; Rev. William A. Shipman; J. Ira Thomas, Assistant Engineer Cambria Steel Co.; Joseph Tomlinson, Fire Boss; Lewis Wales, Clerk; John W. Watkins, Mine Foreman; Fred Zipf, Contractor, Cayll Fan.
Kansas City.—P. D. Shenon.
Kimberly.—F. H. Douthitt, Mine Superintendent.
Landstreet.—A. J. Johnson, Superintendent.
Lechburg.—Charles Briggs, Mine Foreman; Robert Briggs, Mine Foreman; L. W. Hicks, N. S. Hicks, Superintendent; A. A. Lessig, Mine Foreman; H. M. McCallip, Mine Foreman West Penn Mining Co.; Samuel T. Shoff, Mine Foreman; A. L. Walker, Boss Driver.
Lilly.—Nicholas Evans, Superintendent Lilly Coal Co.; George S. Forsythe, Superintendent W. S. Piper & Co.; John A. Leap, Mine Foreman; James J. Stoker, Assistant Superintendent.
Listie.—P. M. Connor, Superintendent of Mines.
Mercer.—Thomas K. Adams, Mine Inspector.
Motollar.—James S. Connor, Mine Foreman; Frank B. Fluck, Mining Engineer.
Mt. Pleasant.—Chas. S. Gause, Division Engineer H. C. Frick Coke Co.
Myra P. O..—G. R. Eaton, Mine Foreman.
New Salem.—Reuben Street, Superintendent Fayette Coke Co.
Patton.—John R. Lloyd, Mine Foreman.
Pittsburg.—S. B. Belden, Jeffrey Manufacturing Co.; Bert Gallatly.
Philipsburg.—Joseph Knapper, Mine Inspector, 8th Bituminous District.
Portage.—E. D. Davis, Mine Foreman.
Pottsville.—Baird Halberstadt, Mining Engineer.
Sherwin.—S. Sherwin, Mine Foreman.
Scranton.—H. H. Stock, Editor MINES AND MINERALS.
Sonman.—Smith Hauxly, Mine Superintendent.
South Fork.—Samuel Brewer.
Turtle Creek.—Thos. B. DeArmit, E. H. Weltzel, Engineer N. Y. & C. G. C. Co.
Uniontown.—Fred. C. Keighley, General Superintendent Oliver & Snyder Steel Co.; John N. King; Albert J. Williams, Mine Foreman Oliver & Snyder Steel Co.
Venetia.—Robert Howag, Mine Foreman; Richard Jones, Mine Foreman.
Vintondale.—Clarence R. Claghorn, Superintendent Lackawanna I. & S. Co.; H. B. Douglas, Superintendent Vinton Colliery Co.; Wm. Penn Morgan, Assistant Superintendent; Robt. G. Ware, Mining Engineer, Lackawanna Iron & Steel Co.
Windber.—Jas. A. Cunningham, Superintendent Berwind-White Coal Mining Co.; John N. Garrett, Chas. E. Sharpless, Assistant Superintendent B. W. C. M. Co.; D. A. Thomas, Mine Superintendent.

WEST VIRGINIA.

Tunnelton.—Grant Watkins, Mine Foreman.

OHIO.

Cleveland.—H. M. Morrison, M. E.
East Palestine.—Geo. Gould, Superintendent Butt's Cannel Coal Co.; Jacob Ashman, Mine Foreman Sterling Mine; W. S. Lewis, Superintendent; George Sutherin, Foreman State Line Mine.

QUEBEC, CANADA.

Montreal.—H. R. Kirkpatrick, Ingersoll-Sergeant Drill Co.

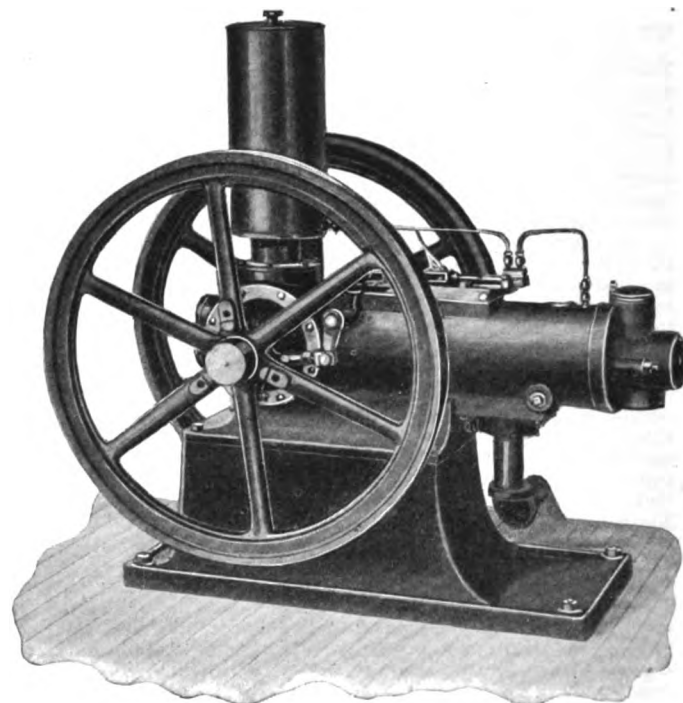
Robins Belt Conveyor Patents Sustained.

On October 15, 1900, the suit of Robins Conveying Belt Co., of New York, against Exeter Machine Works was argued, before Judge Wheeler of the U. S. Circuit Court for the Southern District of New York. The Robins Conveying Belt Co. complained that the Exeter Machine Works had advertised, and in two cases had sold, Belt Conveyor apparatus which infringed Letters Patent Nos. 499,472, dated June 13, 1893, and 571,604, dated November 17, 1896, both of which are the property of the Robins Conveying Belt Co.

On November 15, 1900, Judge Wheeler issued an interlocutory decree, establishing the validity of the patents in question, and an injunction restraining the Exeter Machine Works from infringing or in any way advertising the apparatus covered by these patents. An accounting was ordered before Special Master John M. Shields. His report, dated March 6, 1901, awarded damages to the Robins Conveying Belt Co., which have since been paid.

Kerosene Gas Engines.

The accompanying cut shows a kerosene engine made by Messrs. August Metz, 128-138 Mott Street, New York City. A gas engine has a great many advantages, but the field of its application is of necessity somewhat restricted, as it must be used where there is a gas supply. The usefulness of a kerosene engine has recently been greatly extended, as it is now possible to obtain the fuel in almost any locality and to transport it to any locality where any other variety of fuel can be taken. The working of gas and kerosene engines is the same, the only difference being in the mechanism for injecting the fuel into the cylinder. The Metz & Weiss engine receives at full power an impulse at each turn of the crank-shaft. The compression and burning of the mixture, and the expulsion of the exhaust, are all performed at a



single turn in a direct and simple manner. The engine is dust-proof and the enclosure of the crank-shaft, the absence of cams, valves, and side shafts, obviates all danger to inexperienced attendants. The crank-shaft bearings are rigid, the engine is thoroughly lubricated, and it is said to have no odor whatever about it. The ignition of this engine is effected by compression and is automatic. The fuel supply is enclosed in a closed copper tank or oil receiver, which is firmly screwed to the cylinder, and it has a capacity for a 10-hour run. From this tank, the oil is forced by a pump directly into the cylinder and there vaporized and mixed with the air for combustion. The kerosene engine consumes 1 pint of kerosene per H. P. hour. Small engines use more fuel per H. P. than large ones. The company reports an engine in actual operation at which cost is said to be less than one-half cent per H. P. hour.

These kerosene engines are particularly adapted for mining work on account of the portability of the engine and also of the fuel. No engineer or fireman is required. There are no ashes to be removed and no dirt about the engine. The engine can be started and managed by any person of ordinary intelligence, and since it is automatically lubricated, it requires a minimum of attention.

The United States now holds third place as an exporter of coal while the relative growth of her coal exports by far exceeds that of any other nation. England of course leads as an exporter of coal; Germany occupies second place; the United States third; and Belgium fourth.

Practical Mining Studies

"Practice yourself on little things, and then proceed to greater."

Timbering a Mine Airway.

One of the best criticisms of modern textbooks is that while they describe how a thing ought to be done, they do not tell how to do it. This criticism was brought out a few days since in conversation with a practical miner who has a laudable desire to understand the best methods in mining practice. This man in the opinion of the average miner would be considered as possessing a very fair idea of mining work in general, and of timbering in particular. Most men would be satisfied with this, but to use his own words, while he understood the methods of timbering as

explained in books, "The proposition in a mine airway is a different one from that on paper. Why do you not tell us," said he, "how the sticks are put up?" This, as we said before, is the failing of the modern textbooks; they all answer the questions "Where" and "What," but they do not satisfactorily tell *how* the thing is to be accomplished so that the practical man is benefited. To help these men the writer must be a man of practice himself, and be able to grasp the situation as it is, and not as he would like to have it.

To explain the framing of a timber set and placing the same in position, will seem a trivial matter to some men, but these are usually the men that are easily satisfied with almost anything in practice. It is important in the framing of a set of timbers that they should all have an even, uniform bearing upon each other. This means that the joints must be true and cut to a true line or bevel. A simple timber set, in an airway or passageway having a good floor, will consist of a collar or cross-beam supported by two legs. The legs should each



FIG. 1.

lean inward or toward the center of the airway 2 inches for each foot of height. This may be called the batter of the set. The upper or the small end of each leg must be cut to the same angle as the batter of the timber, so that when the leg

is in position the upper end of the timber will present a flat or horizontal surface to the bearing of the crossbeam or collar. When the floor of the passageway is hard, the lower end of each leg must be cut to the same angle, so as to give a good bearing. In practice an experienced timberman will cut these ends as accurately by the use of his eye as though he had used a templet to guide him. It is seldom that a good timberman will use a templet for this purpose, but as a matter of illustration, if it is desired, such a templet is readily made by sawing a piece of board in the form of

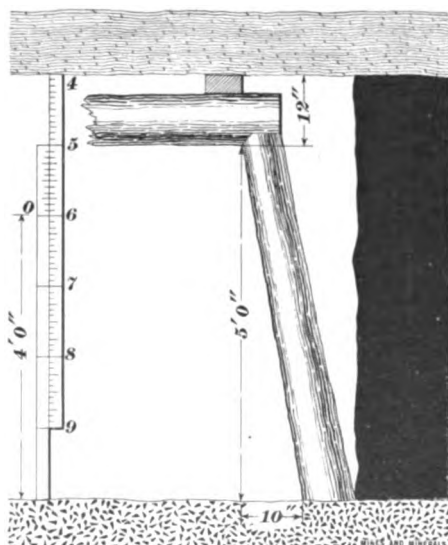


FIG. 2.

whose shorter and longer sides are 4 inches and 24 inches, respectively. If this board or templet is placed against one side of a straight timber, as shown at A, Fig. 1, the end of the board will serve as a guide to cut off the end of the timber upon the lines ab and cd.

The lower end of the leg is cut first, and before cutting the upper end the height of the timber set or the length of the leg must be known. To ascertain this the floor is leveled off where the leg is to set, and the height from the floor to the roof is measured at this point. This is most easily accomplished by two short sticks, say 4 or 5 feet in length. These sticks are shown in Fig. 2, one of them being divided into feet and inches its entire length. The other stick does not require any graduations, except it is convenient to divide the last foot of this stick into inches for the purpose explained later. A line is made upon this stick 1 foot from its upper end, this line is marked 0 as in the figure. In this case the stick being 5 feet in length the zero mark is 4 feet above the floor when the stick is in position, and the graduations upon the other stick must then begin at 4 feet and read downwards. The use of these sticks for measuring the height or the width of an airway will be readily understood, the reading being made upon the second stick at the point marked 0 upon the first stick, to obtain the full height or width of the airway. If it is desired to make allowance of a certain number of inches, as in this case 12 inches for the collar or cross-beam, the reading upon the second rod must be made opposite the 12-inch mark upon the first rod. This reading would then be in this case 5 feet instead of 6 feet as before. If there be an allowance of 8 inches only, the reading upon the second stick opposite the 8-inch mark upon the first stick, will be 5 ft. 4 in. This is a convenient form of measuring stick for use in shafts or airways. When both ends of the

timber have been sawn off another cut must be made at the upper end of the timber upon the line ef, Fig. 1. This line should make an angle of say 45° with the line cd, and the timber should be so cut at this point as to present a bearing surface or shoulder 2 inches wide. The framing of the legs is now finished.

To ascertain the length of the cross-beam or collar, the width of the entry is measured at the bottom where the legs of the timber set are to stand, making an allowance for the lean of the two legs equal to 4 inches for each foot of height or length of leg. Thus, in the sketch, Fig. 2, if the airway at the floor measured 8 feet wide, the legs being 5 feet long, an allowance of $4 \times 5 = 20$ in. would be made, and the length of the collar would then be 8 feet less 20 inches = 6 ft. 4 in. If the cross-beam is round timber, the best side, or the side presenting the most even grain is chosen for the under side. The timber should be so placed that any knots will be upon its upper side. If split timber is used for the cross-beam the split side should be placed uppermost. If the split side is placed downward the exposed fibers are subjected to expansion, as the weight comes on the beam, and are more readily broken than the fibers upon the other side that have not been injured. Saw-cuts are first made at an angle of 45°, and at a distance from each end a trifle greater than the diameter of the small end of the leg. These diagonal cuts should be 2 inches deep to correspond to the 2-inch shoulders on each leg. A longitudinal cut is then made with the saw or with an adz. If the adz is used the workman must be careful to make an even joint or bearing surface.

When all is ready, and the proper wedges to place above the timber are at hand, one leg is stood up against each rib, and the cross-beam or collar is lifted to its place, resting upon the upper ends of the legs. Two men are usually required to do this, especially if the timbers are heavy or the airway high. In a low roof and small timbers one man can often perform the work alone by throwing the collar upon his shoulder and resting one end upon the leg at one side of the entry, while bringing the other leg into position. When this has been done a wedge is inserted above the collar under the roof, so as to hold the timber set temporarily in place. One wedge at each end of the collar will hold the set

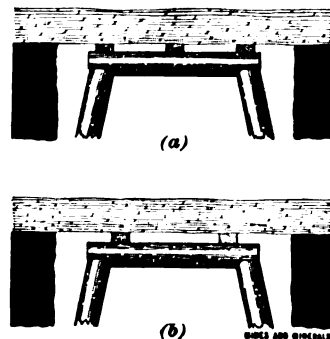


FIG. 3.

temporarily in place while the legs are being adjusted to their true position. This should always be done before the wedges are driven permanently in place.

Much importance attaches to the wedging of a timber set. The wedges should be of oak and cut from 6 to 10 inches in width, and from 2 to 4 inches in thickness, and 12 or 18 inches long, according to the size of the timbers and the height of the airway, nature of the roof, etc. The wedge should have a taper of about 1 inch to the foot. When there is much clearance space between the top of the collar and the roof, two wedges are often driven against each other, one above the other. In driving a wedge the timber should be placed a little out of position toward the side upon which the wedge is driven, since the action of driving will naturally carry the timber forward. If desired, two wedges may be driven side by side, at each end of the collar, but from opposite sides. A wedge should never be driven at the center of the cross-beam, as shown at (a), Fig. 3, except it may be in special cases, and then only after the timbers have taken the weight. The position of the wedges above the collar should be as shown at (b), Fig. 3, slightly inside of or toward the center of the entry from the top of the leg, so that the line of pressure will act to arch the weight over the airway. Two average timbermen can frame and place in position from 12 to 20 sets of timber in a 6-foot airway in an 8-hour shift, but the work will depend very much upon the amount of cutting and trimming required in the floor, ribs, and roof of the airway, and the character of the roof in particular.

Short and Useful Methods in Surveying Practice.

There are many short methods in the practice of surveying known to the engineer, that enable him at times to make long strides toward the completion of his work. In the use of these short cuts the necessary observations are taken by the engineer or

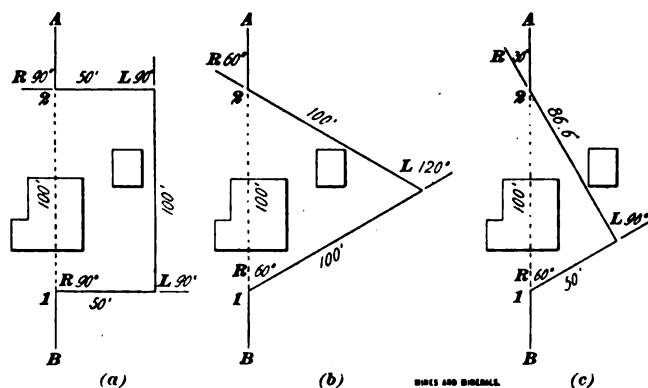


FIG. 1.

transitman without the aid of and unbeknown to his assistants, so that his announcement to them upon their arrival at an unfordable stream or an insurmountable precipice, or other impassable obstruction, that the work is completed beyond such a point, sounds more as a fairy tale than a simple, practical fact that permits them to transfer their base of operations thither without the anticipated laborious toil common to such obstructions. This applies to all work of measurement or location not requiring side notes or profile elevations.

The writer has often in the surveying of townships, sections, land, mining claims, etc., very materially shortened the work by taking observations or sights to certain prominent points, thereby locating such points, or connecting the same with the survey, and making it possible to transfer operations to any one of them. In surveying the land lines or boundary lines of any tract or mining claim, the prominent features can generally be located by observations taken in this manner from different stations or points in the survey. This method saves the labor of running special lines and taking the necessary measurements to locate such points or objects. By taking such observations carefully to the hoisting rope, for example, of a shaft, in the survey of a small mine, the writer has often made connection and carried the surface survey into the mine without apparently approaching the shaft, not infrequently causing the surprise of the onlooker or helper, and eliciting the question, "How do you establish your connections?"

Success in surveying depends to a larger extent than is often recognized by the engineer or surveyor, upon just such time-saving methods as this. We have seen engineers who would scoff at such methods as being inaccurate, but who are themselves so careless in the matter of measuring with the chain or tape, or in observing and reading an angle with the instrument, that their work is wholly unreliable and productive of no absolute results.

The successful engineer possesses an advantage over his competitor by knowing where accuracy is needed. With this man it is an unvarying rule that accuracy begins in the careful and uniform handling of the instrument and measuring line. It is useless to split hairs over tack points, when the chain is 2-tenths long or short, and needs correction, or the instrument out of adjustment.

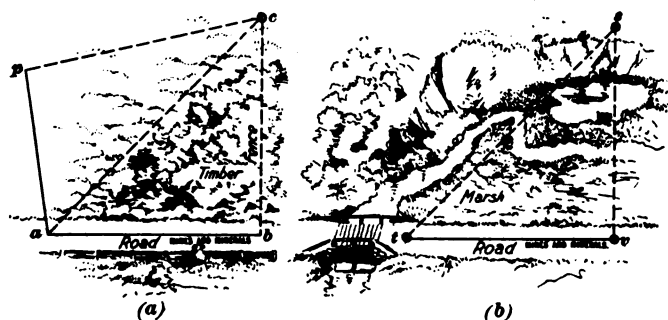


FIG. 2.

It may seem a strong statement but it is nevertheless a fact that many engineers cannot measure 1,000 feet in a direct line upon level ground and then measure back upon the same line and tally on the starting point. Many do not know that the ordinary engineer's steel tape is graduated under a tension or pull of 10 pounds, and that a difference of 10 pounds in the pull exerted upon the tape, or a difference of $31\frac{1}{2}^{\circ}$ F. in temperature will either of them produce a variation of $\frac{1}{4}$ -inch per hundred feet of length in the measuring line. In spite of ignoring these corrections, we find men measuring and sighting with the most careful scrutiny to plumb-lines and tack points, and consuming hours upon a Sabbath or rest day in vainly trying to "plumb a shaft."

The point we wish to emphasize here is that much time is to be saved by the various expedients adopted by the transitman in charge of the survey. We will mention a few of these points.

Passing Obstacles.—When a line of survey runs through a house or barn, or crosses a timber patch, marsh, or other piece of ground that it is desirable to avoid, the engineer or surveyor often squares off and runs upon an offset line parallel to the line of survey, and at such a distance from it that the obstruction is avoided. The method of squaring off is illustrated at (a) Fig. 1, and will be readily understood. This method requires turning off four angles, two to the right, and two to the left. It is often preferable to adopt one of the methods shown at (b) or (c), either of these methods requiring the turning off of only three angles. The method shown at (b) requires no calculation, since the deflected lines avoiding the obstruction form two sides of an equilateral triangle, and the intercepted portion of the survey line AB is, therefore, equal to the length of either of the deflected lines run to avoid the obstruction. At (c) the intercepted portion of the survey line AB is double the length of the shorter one of the two deflected lines. In this method the first angle deflected may be either 60° or 30° , but in either case the longer of the two deflected lines must be 1.732 times the shorter. It is evident that any other angles may be used in avoiding obstructions, but always the sum of the angles turned to the right must be equal to the sum of the angles turned to the left; and it is more convenient to use such angles as 30° and 60° , or 60° and 60° , or 45° and 45° . In the latter case which we have not illustrated, the deflecting lines will form the two equal sides of an isosceles triangle. The hypotenuse of this triangle is the intercepted portion of the survey line, and is always 1.414 times the length of either of the deflected lines.

Triangulation.—We do not refer here to such triangulation as requires an independent base line. We assume the method of triangulation is understood, and only wish to draw attention to the fact that time and labor may often be saved by taking observations from any two stations of the survey from which some desired point can be seen. It is not necessary that such point be in the boundary line of the survey; it may be situated near such boundary or corner. This is illustrated in Fig. 2 (a) and (b). In

FIG. 3.

the former by observing the point c from any two convenient stations of the survey its position is determined, and it will not then be necessary to carry the survey from station b to c through the dense timber and underbrush shown in the cut; but having completed the survey to b the instrument can be moved to c and backsight taken to p or a , or any other station from which c has been observed, and the survey continued. In like manner in (b) the point s at the top of a precipitous bluff is observed from the stations t and v upon the road in the valley. A simple calculation will then determine the position of the point s , and the survey can be continued by removing the instrument to that point. The points c and s , Fig. 2, may be located by sending a flagman forward, or a prominent feature of the landscape may be sighted, as the lone pine upon the precipitous bluff shown in Fig. 3, or the church spire in Fig. 4, and these may be taken as reference points. It is not necessary that such reference points be accessible for the setting up of the instrument over them. In Fig. 3 the instrument is shown as having been carried forward and set up at o upon the line vs at any convenient distance from the pine tree or reference point. This distance may be measured after the instrument is set up by measuring the distance os to the center of the pine tree, or it may be ignored for the present and the length of the line vs corrected later by taking an observation from some point p upon the line op . Again the reference point s may be such as to be wholly inaccessible, as for example, the church spire shown in Fig. 4. In this case x being the inaccessible point under the spire of the church, the instrument is carried forward and lined in at some point o on the line vx , and the survey is then continued along the line op . The length of the line vx is corrected as before, by an observation of the spire from some point p . In all these figures

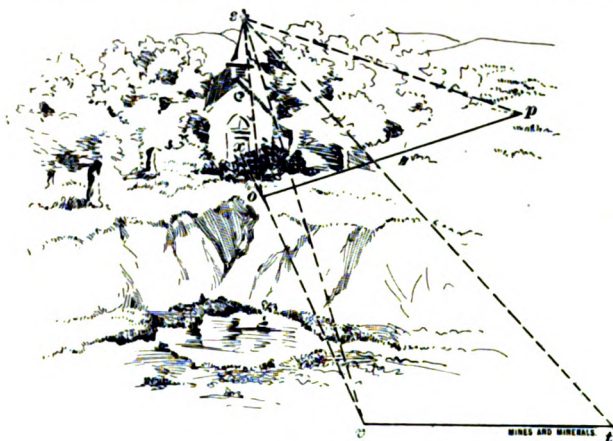


FIG. 4.

the measured lines vt and op of the survey are drawn full, while the sight lines vs , ts , os , and ps , are dotted.

It must not be supposed that this method of surveying by means of inaccessible reference points possesses any elements of inaccuracy, it is on the contrary, one of the most accurate methods of surveying that can be employed, since the reference points are fixed and afford rigid, permanent sights that can often be seen a long distance. A triangulation from a carefully measured base line is susceptible of more accurate work by far than would result from chaining or measuring the same distance. One of the most prolific sources of error in surveying practice is the inaccuracy due to chaining over bad country, and the most serious hindrance to a survey arises when a line must be cut through timber and undergrowth; hence, any means for the avoidance of these difficulties will save time and labor.

Wonderland 1901, the annual publication of the Northern Pacific Railway will be found a distinct advance in some respects upon even its immediate predecessor, Wonderland 1900. Its cover designs and eight chapter headings are by Alfred Lenz, of New York, from plastique models, and are splendid examples of art. There is within the covers of the book much historical matter, some of it new, as well as purely descriptive narrative. The three principal chapters relate to the history of the unique Northern Pacific trade mark, the Custer battlefield in Montana, and Yellowstone Park. Each is profusely illustrated, the trademark chapter in colors. The trade mark is of Chinese origin and is 5,000 years old. Its story is a strange one. It is safe to say that Wonderland 1901 will be in greater demand than any preceding volume of the Wonderland family, and as heretofore it will be sent by Chas. S. Fee, St. Paul, Minn., to any address upon receipt of the postage, six cents.

Direct and Alternating Currents.

There are many men engaged in electrical pursuits who are well posted on matters relating to direct currents and direct-current apparatus, but who feel that they are not as well up on alternating currents. The reasons for this are not far to seek. In the first place, alternating currents and alternating-current machinery have not been in use as long as direct-current apparatus. Alternating currents have only come into extended use during the last 8 or 10 years. In the second place, most of the books on alternating currents are difficult to understand on account of the mathematics used, so that the average reader gives up studying the subject, even though there may be much in these books that he could easily understand.

We do not wish, for an instant, to belittle the use of mathematics in connection with alternating-current work. It is absolutely necessary for a complete treatment of the subject. At the same time there are many facts in connection with alternating currents that can be set before the reader with the use of but very little mathematics, and it is a few of these points that we wish to bring out for the benefit of those who are called upon to operate alternating-current machinery and who wish a general understanding of

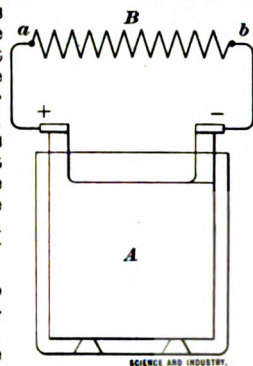
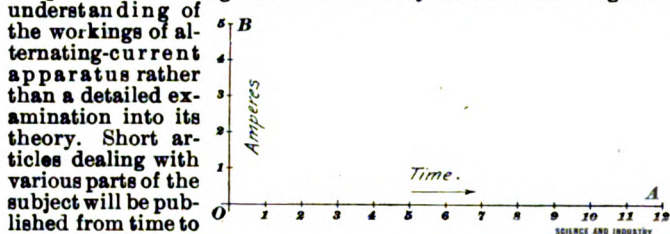
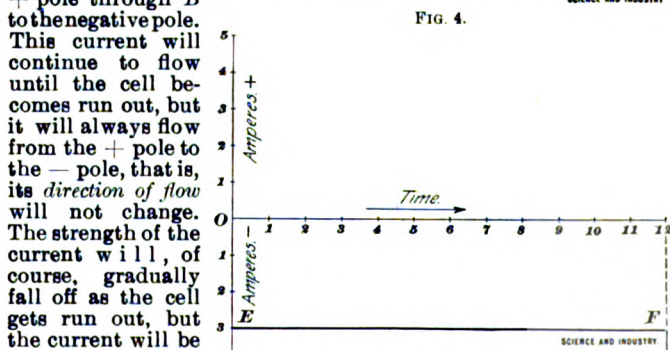
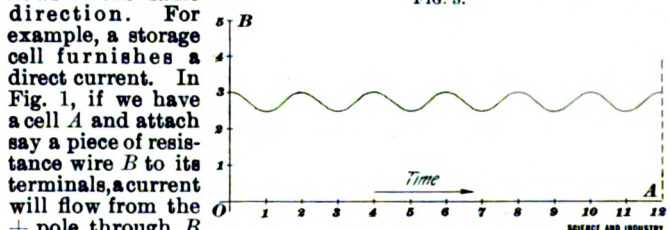


FIG. 1.



the workings of alternating-current apparatus rather than a detailed examination into its theory. Short articles dealing with various parts of the subject will be published from time to time, and in this article we will confine ourselves to looking at a few of the differences between a direct and an alternating current.

When we speak of a direct current we mean a current that always flows in the same direction. For example, a storage cell furnishes a direct current. In Fig. 1, if we have a cell A and attach say a piece of resistance wire B to its terminals, a current will flow from the + pole through B to the negative pole.



This current will continue to flow until the cell becomes run out, but it will always flow from the + pole to the - pole, that is, its direction of flow will not change. The strength of the current will, of course, gradually fall off as the cell gets run out, but the current will be smooth and steady and there will be scarcely any fluctuations in it. For this reason a current of this kind is called a continuous current.

In order to study the flow of currents it is necessary for us to have some way of representing the flow on paper. We can do

this for the case shown in Fig. 1, as follows: In Fig. 2, let OA be a horizontal line and OB a vertical line. Now, suppose we lay off time to scale along OA , that is, divide OA up into equal divisions and let each division represent a certain length of time, as a minute, an hour, or whatever may be convenient. We will suppose in this case that each division represents 1 minute, and the farther we get out along OA the greater the length of time that has elapsed. From O to 9 represents a period of 9 minutes, from O to 5 a period of 5 minutes, and so on. In a similar manner we can lay off on OB , counting from O up, distances corresponding to the current. For example, we may call each vertical division an ampere. We will suppose in Fig. 1 that the cell A is large enough so that it will deliver a uniform current for the 12 minutes laid off on our diagram, and that the resistance is of such amount that the cell can force 3 amperes through it. At every instant during the 12 minutes, then, the cell gives 3 amperes, and hence we can represent the flow of the current during the 12 minutes by the horizontal line CD , Fig. 3. The line CD represents a *direct current* and it also represents a *continuous current*, because the current not only flows in the same direction all the time but its value remains the same. The terms *direct* and *continuous*, as applied to electric currents, are often used indiscriminately, though there is really a difference. Suppose that instead of having a simple resistance wire in Fig. 1, we inserted a regular resistance box, provided with a switch having a large number of contacts, so that the resistance could be gradually increased and decreased. If resistance is gradually cut in, the current will,

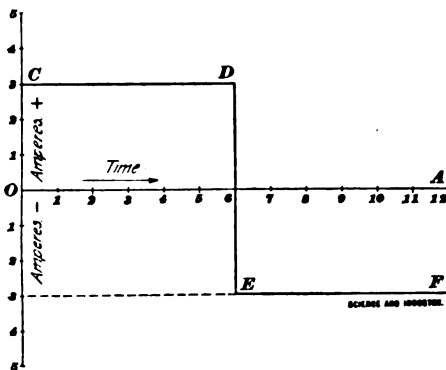


FIG. 6.

of course, decrease, and when it is cut out again it will rise to its original value. The current would, therefore, rise and fall as indicated by the wavy line, Fig. 4. The current does not reverse the direction of its flow; it merely increases and decreases, being therefore a *direct current*, but not a *continuous one*. The current given by an ordinary continuous-current dynamo is not strictly continuous, but if the number of commutator bars is at all large it becomes practically so and is generally so considered. Some arc-light dynamos give a current which, while it is always in the same direction, nevertheless fluctuates. Arc machines with few armature coils, such as the Brush or Thomson-Houston types, give a current of this character.

We have taken the line CD , Fig. 3, to represent the current flowing from a to b through the resistance in Fig. 1. Suppose that we disconnect the cell from the wire at a and b and interchange the ends so that the + side of the cell is connected to b and the - side to a . The current will then flow from b to a , or in the opposite direction to what it did before the connections were changed. The question now arises, how shall this current in the opposite direction be represented? It can be done by means of a diagram similar to that shown in Fig. 3, by adopting the rule that if the line CD above OA represents a current in one direction, say from a to b , then we may represent a current in the other direction by a line EF below the horizontal, as shown in Fig. 5. In other words, all currents flowing from a to b we may call *positive currents* and represent them above the line OA , and all currents from b to a we may call *negative currents* and represent them below OA .

In Fig. 6 the current of 3 amperes is allowed to flow in the positive direction from a to b for an interval of 6 minutes, and is therefore represented by CD . The connections are then instantly reversed and the current passes through zero and flows for a period of 6 minutes in the opposite direction, as represented by the line EF below OA .

If we connected a reversing switch between the battery and

the wire, Fig. 7, and worked it back and forth at a uniform rate, we could make the current flow first in one direction and then in the other, as shown in Fig. 8, where the current is allowed to flow for 2 minutes on each position. The wavy line thus obtained represents to the eye the nature of the current which flows in the wire when the current is reversed at equal intervals. The line shows that the current first flows for 2 minutes in the positive direction, then reverses and flows for 2 minutes in the opposite direction, then changes back and flows for 2 minutes more in the positive direction, and so on. In other words, the current alternately flows first in one direction and then in the other, or it is an *alternating current*. Compare Fig. 6 with Fig. 4. In Fig. 4 the current varies up and down but never reverses, while in Fig. 6 it reverses, and every time it reverses, the current, of course, has to pass through zero. An alternating current is, therefore, one that periodically reverses its direction of flow, and in this case the alternating current has been produced by simply reversing a continuous current at fixed intervals. In practice alternating currents are generated directly by dynamos or alternators made for the purpose, and the variations of the current so produced would

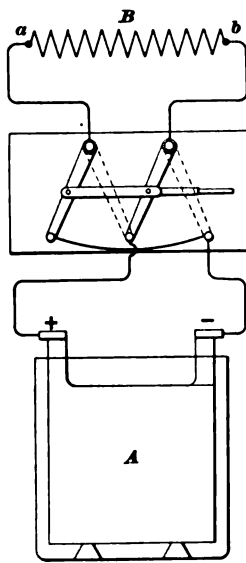


FIG. 7.

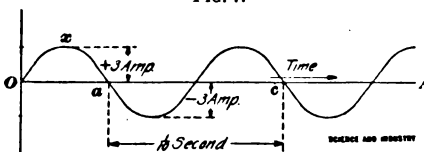


FIG. 9.

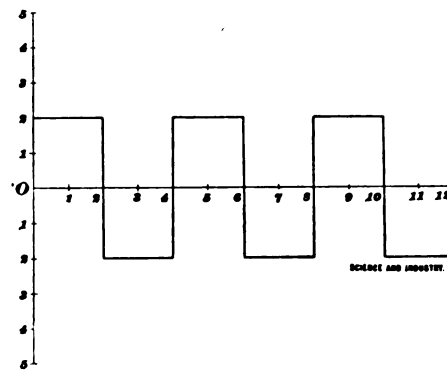


FIG. 8.

the flow of the current is sometimes called a *current wave*. In this case we have supposed that the current passes through a complete set of its values, both positive and negative, in $\frac{1}{10}$ second, i.e., the distance ac is laid off to scale to represent an interval of time of $\frac{1}{10}$ second.

The above will serve to point out some of the differences between the flow of a direct current and that of an alternating current. The next step will be to consider these current curves a little more fully and look into the way in which alternating current is generated.

Sines, Cosines, Tangents, as Ratios.

There are many things in the calculation of mining problems that appear difficult to the student, and especially to the beginner; some of these difficulties are real, but many are imaginary. Things are often made *difficult* or *easy* by the way in which we look at them. If we neglect the study of the elements of a science we cannot expect to understand clearly what that science teaches.

For example, we will ask what we mean when we speak of the *sine*, *cosine*, or *tangent* of an angle. We are familiar with the figure usually drawn (see Fig. 1) that represents these several terms as lines in a circle, but this does not convey to us their true meaning. These terms do not refer to lines as *lines only*, but are *ratios*; in other words each expresses the ratio that such line bears to the radius of the circle. These ratios are of particular use in the measurement of angles, or as we say, in circular measurement. Each line, as shown in Fig. 1, has a particular position with reference to the radius of the circle and the angle which it subtends. The mistake is often made of calling these lines the *actual sine*, *cosine*, *tangent*, etc. of the angle.

In order to assist us in the application of these terms to the solution of triangles, we must understand that *they are not lines*, but express the ratio that certain lines bear to each other. To show this more clearly we have drawn, in Fig. 2, circles of different sizes, and have marked the several lines s , c , t , respectively, instead

of marking them as in Fig. 1, so as not to confuse these terms with the idea that they are lines; the radius of the circle is marked r . It is clear at once that for the same angle, while the several lines have a different length in each circle, and are hence unequal, the ratio that each bears to the radius of the circle is constant, and is, therefore, a measure of the angle.

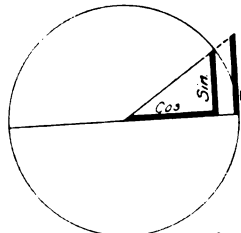


FIG. 1.

It will now be clear that any angle may be measured by any one of the ratios $\frac{s}{r}$, or $\frac{c}{r}$, or $\frac{t}{r}$; that is to say, when the ratio that the length of such line s , c , or t , in any circle bears to the radius of the circle is known, the angle which it describes is known. For example, take the angle 30° ; the sine of this angle is .5, cos .866, tan .57735. That is to say, these decimals express the ratios that these several lines, s , c , and t , bear, respectively, to the radius r in any circle, for an angle of 30° , and in this manner every angle presents a new set of ratios that these lines bear to the radius of the circle. These lines are thus expressed as the decimal part of the radius.

Application to Triangles.—We go now one step further and apply this relationship between the several lines, s , c , t , and r , to the solution of right-angled triangles. Referring to Fig. 3, and comparing the two triangles there shown with those in Fig. 2, it is evident that the *sine* of either of the acute angles of a right-angled triangle is the ratio that the side lying opposite to the angle bears to the hypotenuse, while the *cosine* of either angle is the ratio that the side lying adjacent to the angle bears to the hypotenuse, Fig. 3 (a). On the other hand the *tangent* of either of the acute angles

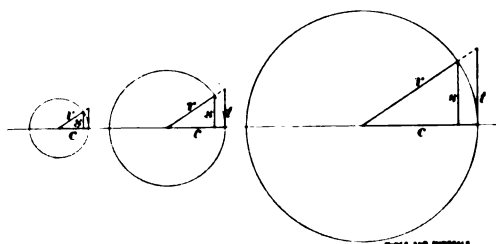


FIG. 2.

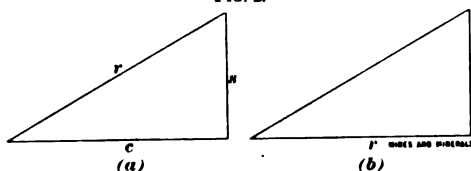


FIG. 3.

of a right-angled triangle is the ratio that the side lying opposite to the angle bears to the other side, not the hypotenuse, Fig. 3 (b). This gives the following formulas for the solution of any right-angled triangle:

- | | | |
|-----------------------|---|----|
| Sine of acute angle = | $\frac{\text{side opposite the angle}}{\text{hypotenuse}}$ | 1. |
| Cos of acute angle = | $\frac{\text{side adjacent the angle}}{\text{hypotenuse}}$ | 2. |
| Tan of acute angle = | $\frac{\text{side opposite the angle}}{\text{side adjacent the angle}}$ | 3. |

These three expressions for the sine, cosine, and tangent of the acute angle of a right-angled triangle are the only formulas that we are required to memorize. We should not indeed

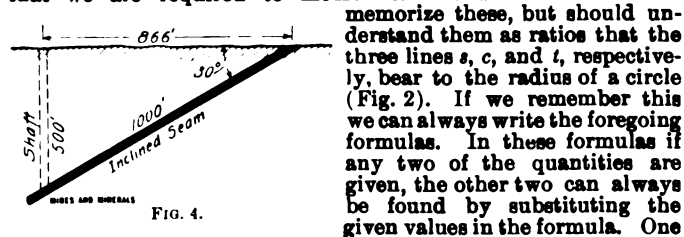


FIG. 4.

or two examples will make this clear.

PRACTICAL EXAMPLES.

EXAMPLE.—Depth of Shaft, Inclined Seam.—A seam has an inclination of 30° from the horizontal. If the surface is level, what will be the depth of a shaft to strike this seam at a distance of 1,000 feet from the mouth of the slope?

SOLUTION.—Referring to Fig. 4 we observe that the depth of

the shaft is a line corresponding to the side of a right-angled triangle lying opposite to the given angle. The sine of the angle, therefore, expresses the ratio between the depth of the shaft and the length of the slope. Since $\sin 30^\circ = .5$, the depth of the shaft is $\frac{1}{2}$ of the length of the slope, or the shaft is 500 feet deep.

EXAMPLE.—Inclined Seam.—At what distance from the mouth of the slope in the last example must the shaft be sunk in order to meet the slope at a distance of 1,000 feet upon the incline?

SOLUTION.—Referring to the same figure we observe that the distance from the mouth of the slope to the mouth of the shaft upon the surface is a line corresponding to that side of a right-angled triangle lying adjacent to the given angle, or forming one of the sides of the angle. The cosine of the angle in this case expresses, therefore, the ratio between this distance and the length of the incline. The cosine of 30° being .866, the distance from the mouth of the slope to the mouth of the shaft upon the surface is $.866 \times 1,000 = 866$ ft.

ROCK DETERMINATION.

The Western Editor of MINES AND MINERALS will, without charge, examine and name, so far as possible, samples of rock sent him, the answers being sent by postal card to the sender of the specimen. He will only undertake to name average rocks, such as can be fairly determined at sight; and microscopic or chemical analyses will not be attempted; neither is it always possible to determine with absolute precision and certainty a small sample, or one decomposed and oxidized, and with such samples the sender must be content with the provisional determination that it *APPEARS* like such and such a rock.

Questions involving an opinion on mining property, for which an expert would be entitled to a fee, will not be answered, but advice that will aid the prospector will be given.

The following conditions must be observed by those sending specimens for determination:

The specimens should be fresh and about 2 inches square.

Each should be distinctly labeled.

The name and address of the sender, written very distinctly, must be enclosed in the package.

The package should be sent prepaid to Prof. Arthur Lakes, Room 516 Boston Building, Denver, Col.

A letter should accompany the specimens describing the locality, mode of occurrence of the rock and other facts, and rough sketches may accompany such descriptions.

Samples will not be returned unless by request, and where stamps are enclosed to cover postage or expressage and cost of packing.

Rock-Forming Minerals.

Quartz.—Quartz occurs in six-sided prisms, terminating in six-sided pyramids. No cleavage is apparent, but it is sometimes obtained by heating the crystal and plunging it into cold water. Quartz sometimes occurs in coarse, radiating forms, like a rosette or star; also coarse and finely granular, showing no crystal form at all, like flint for example, or it may hang from the roof of a cavity in stalactites, or coat the cavity all around with a surface of low rounded protuberances called mammillary shapes, shown herewith, or with rounded surfaces like bunches of grapes, called botryoidal structures. Chalcedony, or agate quartz, is particularly liable to assume these last two forms.

Quartz is often perfectly clear and colorless, but it may be stained various colors by mineral solutions, such as topaz-yellow, purple, amethystine, delicate rose, smoky, like smoked glass, or it may be of various shades of yellow, green, blue, and brown to black, whilst in some varieties, as in the familiar Brazilian agates, it is in bands, stripes, and clouds. It may range through all degrees of transparency to opaqueness. Its luster is generally vitreous or glassy, though some massive forms are dull or waxy. The hardness is 7. Specific gravity 2.5—2.8.

Composition, SiO_2 = silicon 46.67, oxygen 53.33. It is infusible before the blow pipe, but with soda fuses with intumescence.

Common mineral impurities associated with quartz, and which can often be seen inside a quartz crystal, are chlorite, rutile, asbestos, actinolite, tourmaline, hematite, limonite. Hematite (or red iron oxide) is the usual red coloring matter. Limonite, as yellow ochre may give the yellow and brownish color. Chlorite and actinolite give a green color, and an oxide or silicate of nickel, an apple green tint. Manganese gives a purple



QUARTZ CRYSTALS.

amethystine tint; carbonaceous matters, such as tint marsh waters, give smoke-brown shades. Quartz crystals often contain liquids in cavities, either water, petroleum, or liquid carbon-dioxide. Chalcedony usually has more or less disseminated opal, which may be milk-white, or blue, or other colors, and clear quartz is often spangled with scales of mica. Flint, or chert, is often colored by mixture with the material of the enclosing rock and surrounded by white lime from the chalk.

Quartz is very various in color and form, but may be distinguished by (1) absence of true cleavage; (2) its hardness; (3) its infusibility before the blowpipe; (4) its insolubility with either of the common acids; (5) when crystallized, by the forms of its crystals which are almost always six-sided prisms terminating in six-sided pyramids. Among these different tests the commonest are its failure to effervesce under acid, the failure to be scratched with a knife, and the fact that it will scratch a glass window pane.

The varieties of quartz owe their peculiarities either to crystallization, mode of formation, or impurities. These varieties may be included under three series:

First.—Vitreous or glassy quartz, with glassy fracture.

Second.—Chalcedonic varieties, having a subvitreous or waxy luster, and generally translucent.

Third.—Jaspery cryptocrystalline varieties, that show no signs of crystalline structure, with but little or no luster, and opaque.

VITREOUS VARIETIES.

Rock crystal, pure pellucid quartz, such as the noted clear quartz crystals of the Arkansas hot springs to be seen in most cabinets, and which are cut for gems.

Amethyst, beautiful purple or violet crystals, also a gem.

Pink or rose quartz, generally massive, of exquisite rose color, especially when held up to the light.

Smoky quartz crystals, sometimes over a foot in length of a smoky tint, often found around Pikes Peak, associated with green "Amazon stone" feldspars.

Milky quartz, milk white, nearly opaque, massive, common.

Rusty quartz, stained yellow by iron oxide.

CHALCEDONIC VARIETIES.

Chalcedony is translucent, massive, with waxy luster of a pale gray or bluish tint, often occurs lining or filling cavities in volcanic or other rocks deposited there by infiltrating siliceous waters; stalactites of chalcedony, or grap-like forms, may hang from the roof of the cavity. Carnelian is bright red chalcedony of clear rich tint. Fossil bones sometimes contain carnelian.

Sard, a deep brown-red chalcedony of a blood red color, by transmitted light.

Agate, a variegated chalcedony, colors in clouds, spots, or concentric bands. These bands are the edges of layers of chalcedony from successive deposits. Moss agate is a brownish or bluish agate, consisting of chalcedony with moss-like delineations of dendrite, resulting from infiltration and crystallization of manganese or iron.

Onyx, a kind of agate having colors arranged in flat, horizontal layers, colors light, clear brown, or opaque white. When the stone consists of sard and white chalcedony in alternate layers it is called sardonyx. Onyx is used for cameos.

Flint, Hornstone, Chert.—Massive, compact silica of dark shades of smoky gray, brown or black, feebly translucent, breaking with sharp cutting edges, and conchoidal or shell-like fracture. Flint occurs in nodules in chalk. Hornstone is more brittle, but is the same as flint and is common in limestone. Chert is an impure hornstone, also characteristic of certain limestones called cherty limestones.

JASPERY VARIETIES.

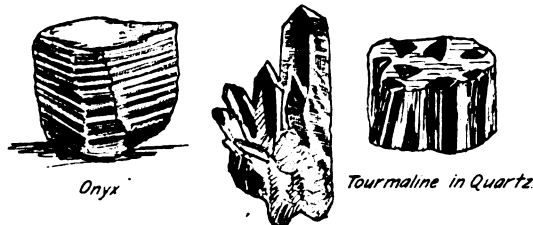
Jasper.—A dull opaque, red, yellow or brownish siliceous rock, sometimes green and other shades. Ribbon jasper consists of broad stripes of green-yellow, gray, red or brown.

Porcelain jasper is only a baked clay differing from jasper in being fusible under the blowpipe. Jasper admits of high polish.

Lydianstone, "Touchstone," Basanite.—Velvet black and opaque used on account of its hardness and black color for trying the purity of the precious metals. This is done by comparing the color of the mark left on it with that of an alloy of well known character.

Granular quartz, or quartzite, is a rock consisting of quartz grains compactly cemented. The colors are white, gray, flesh-colored, yellow or brown. It is a hard siliceous sandstone; in other words a quartzite.

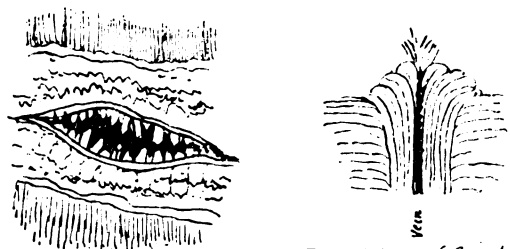
Silicified Wood.—So called "petrified wood" consists often of quartz which has taken the place of the original wood; in some



Onyx

Tourmaline in Quartz

Quartz Crystal.



Quartz geodes in a vein.

Banded layer of Quartz.

MINES AND MINERALS

specimens the wood is changed into chalcedony and agate of various colors.

OPAL.

Opal is compact and amorphous, also earthy, and in stalactites. Colors, white, yellow, red, brown, green, blue and gray; waxy to subvitreous; consists of silica like quartz, but of silica in a different molecular state, the hardness and specific gravity being less, and it being soluble in strong alkaline solution if heated; contains a small percentage of water; differs from quartz in luster and is more waxy than chalcedony, also in the absence of a crystalline texture. Precious opal is milky with a play of delicate tints. Fire opal has yellow and bright hyacinth or fire reflections.

Common Opal is resinous with no colored reflections, but a milky opalescence. Colors are white, gray, red, yellow, bluish greenish. Translucent to nearly opaque; occurs sometimes in silicified wood, and is called wood opal.

Cacholong opaque white, associated with chalcedony.

Hyalite is glassy transparent in small concretions like tapioca or gum arabic, sometimes covers the surface of a lava like melting ice, frost, or melted glass.

Silicious sinter or geyserite is a loose porous silicious rock, grayish to white, deposited around geysers in stalactitic or cauliflower-like shapes.

Tripolite or "infusorial earth" is a white or grayish-white earth, massive, or laminated, made up of silicious secretions of microscopic plants called diatoms with spicules of sponges. It forms beds of considerable extent; often occurs below peat; it is used as a polishing powder, and in manufacture of explosives and India rubber. Infusibility before the blowpipe distinguishes opal from pitchstone and pearlstone.

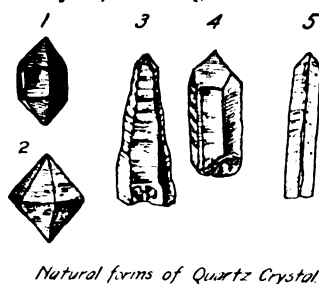
Graphite brushes are not new in the electrical field, as pure graphite possesses the qualities of low resistance, wonderful smoothness and freedom from grit, and as it is the best solid lubricant known there would seem to be no good reason why a graphite brush, if properly made, should not find a ready market.

The Joseph Dixon Crucible Co., Jersey City, N. J., makes daily use of generators and motors in its factories, and for the past three years has made use of graphite brushes of its own make.

Electrical engineers who have seen the commutators on which the Dixon graphite brushes have been used for two or three years, have expressed great surprise at the slight wear of the brushes and commutators, and at the general perfect condition and freedom from burns and sparking.

It is for this experience that the company has no hesitation in offering the Dixon graphite brushes to electricians generally. In fact, the company has full confidence that Dixon's graphite brushes will be found superior to any kind of brush in the market.

The company is sending out price lists indexed under the names of makes of motors, showing sizes and prices of brushes.



Natural forms of Quartz Crystal



Botryoidal & Stalactitic chalcedony.

Agate geode.

MINES AND MINERALS

EXAMINATION QUESTIONS

For

Mine Managers, Mine Foremen, Fire Bosses, Etc.

EDITED BY J. T. BEARD, C. E., E. M.

Answers to the questions given by the several Boards of Examiners will be made as concise as possible, and in case the same question has been answered in the current volume the reader will be referred to the answer already given. When they will throw additional light upon the subject of the question, short notes of explanation will be placed in brackets in connection with the answer proper.

Many of the questions suggest principles that can be more satisfactorily discussed in a separate article than is advisable in an answer to an examination question. Such articles will be published in this department as a help to those preparing themselves for examinations.

All persons interested are invited to send to MINES AND MINERALS copies of questions asked at any examination as soon as possible after the examination is held.

Mine Managers' Examination, Held at Nanaimo, B. C., Canada, December, 12, 13, and 14, 1900.

(Continued from June).

Correction.—Attention has been called to an error in the answer to Ques. 10, page 516, of the last issue. In this answer, the formula giving the diameter of the water cylinder was used instead of the formula for the diameter of the steam cylinder, and 15 inches, the diameter of the water piston, was taken and substituted for the diameter of the steam cylinder. The answer obtained was, therefore, too small, and as a result the discharge of the pump was likewise too small. The latter part of the answer should read as follows:

$$\text{Then, } D = d \sqrt{\frac{.85 p_e}{.75 p_s}} = 15 \sqrt{\frac{.85 \times .434 \times 310}{.75 \times 50}} = 26.2 \text{ in.}$$

To find the discharge of this pump, we have the formula

$$G = \frac{.85(.7854 d^2 S \times 12)}{231} = \frac{.85(.7854 \times 26.2^2 \times 100 \times 12)}{231} =$$

2,380 gal. per min.

In this formula,

G = water discharged (gal. per min.);

d = diameter of water piston or plunger (in.);

S = piston speed of the pump (ft. per min.).

MINING ACT AND RULES.

QUES. 1.—What are the duties of a manager as provided in the Special Rules?

Ans.—Rule 1 specifies that the mine or division of the mine, when divided under the statute, over which the manager has been appointed, shall be under his control and daily supervision. The rule makes it the duty of the manager to carry out and see carried out the various provisions of the Coal Mines Regulation Act, so far as is incumbent on him and those acting under his control and direction, and to see that sufficient materials and appliances are provided for the proper carrying out of all necessary operations.

QUES. 2.—What are the requirements of the Act with regard to the working places?

Ans.—Rules 3 and 4 of Art. 82 of the Mining Act require that every working place shall be examined before work is commenced therein, such examination to be made by a competent person or persons; a safety lamp to be used for the purpose in all mines where inflammable gas has been found within the preceding 12 months. In mines in which inflammable gas has not been found for a period of 12 months preceding, the working places are examined as far as reasonably practicable, and reported to be safe before work is commenced therein. Rule 5 requires that all entrances to places not in actual course of working shall be properly fenced across the whole width of such entrances so as to prevent persons entering the same unwarned.

QUES. 3.—What are the requirements of the Act as to one or more shafts?

Ans.—Section 24 of the Act makes it unlawful for any person to be employed or to enter any mine for the purpose of employment therein unless there are in communication with every seam of such mine at least 2 shafts or outlets, separated by not less than 10 feet of natural strata. Such shafts or outlets to provide separate and distinct means of ingress and egress that will be available to the persons employed therein; provided also that said two shafts or outlets may belong to the same or to different mines. The section also provides that there shall be a communication not less than 4 feet wide and 3 feet high between said two shafts or outlets, and that there shall be at each of said shafts or outlets, proper apparatus for raising and lowering persons, and they shall be either in actual use or available for use within a reasonable time.

QUES. 4.—What does the Act say as to the examination of machinery, shaft, ropes, etc.?

Ans.—Rule 31 of Section 82 makes it lawful for the persons employed in a mine to appoint one or two of their number to inspect the mine at their own cost, and provides that the person

so appointed shall be allowed once or oftener in every shift, day, week, or month, to go to every part of the mine and to inspect the shafts, levels, planes, working places, return airways, ventilating apparatus, old workings, and machinery, and shall be afforded by the owner, agent, manager, and all persons in the mine every facility for making such inspection. The Rule makes it the duty of the person or persons making such inspection to enter a true report of the same in the book kept at the mine for that purpose, and to sign the same, and also provides that if the reports state the existence or apprehended existence of any danger, the owner, agent, or manager shall forthwith cause a true copy of such report to be sent to the inspector of the district.

QUES. 5.—Wherever explosive gas is known to exist, and safety lamps are used, what are the precautions mentioned in the Special Rules?

Ans.—Rule 75 of the Special Rules provides that wherever explosive gas is known to exist, and safety lamps are used, no person shall be allowed to smoke tobacco in such part of the mine, or to have in his possession any lucifer match or other material intended for lighting tobacco. And Rule 76 further provides that wherever safety lamps are required or directed to be used, no person shall use any open lamp.

QUES. 6.—What are the requirements of the Act with respect to the management of mines?

Ans.—Section 31 provides that every mine to which the Mining Act applies, shall be under the control and daily supervision of a manager, and that the owner or agent of such mine shall appoint himself or some other person other than the contractor for getting the coal in such mine or a person in the employ of such contractor, to be manager of said mine, and shall send written notice to the district inspector giving the name and address of such manager. Section 32 provides that the manager of the mine must be registered as the holder of a certificate under this Act.

QUES. 7.—What is stated in the General Rules as regards gunpowder or other explosives used in mines?

Ans.—General Rule 9 provides that gunpowder or other explosive (a) Shall not be stored in a mine. (b) Shall not be taken into a mine except in a case or canister containing not more than 4 pounds. (c) No workman shall have in use at one time in any one place more than one such canister. (d) No iron or steel pricker or tamping rod or stemmer shall be used, and no person shall have in his possession in a mine, such an iron or steel pricker, tamping rod, or stemmer. (e) No explosive shall be forcibly pressed into a hole of insufficient size, or unrammed when a hole misses fire except with the sanction and under the supervision of a shot examiner, and then only when another hole cannot be bored at a distance of at least 2 feet from the charged hole as required by the Act. (f) No explosive shall be taken into or be in the possession of any person in any mine, except in cartridges, and shall not be used therein except by or under the direction of a competent person appointed for the purpose of examining and supervising all shots. Such person before firing or permitting a shot to be fired shall examine all places within a radius of 25 yards and find them safe. (g) This Rule applies alike to all panels or divisions of a mine as to a separate mine, whenever such panel or division has an independent intake and return airway.

QUES. 8.—What is stated in the General Rules regarding machinery used in raising or lowering men in a shaft?

Ans.—General Rules 21-24 provide that in all cases where men are raised or lowered, a sufficient overhead cover shall be used in every working shaft, except where a windlass is used or a person is employed about a pump or some work of repair, or where a written exemption is given by the inspector of the district. Also, that a single-link chain shall not be used in any shaft or on any plane, except only a short coupling chain attached to the cage or load. Also winding drums shall be provided with such flanges or other appliances as may be necessary to prevent the rope from slipping. And there shall be attached to every drum worked by power an adequate brake, and in addition to any mark upon the rope there shall be also a proper indicator to show the position of the cage or load in the shaft.

QUES. 9.—What are the duties of mine fireman as provided by the Special Rules?

Ans.—To inspect and examine the roadways and working places of the mine, and to make a report thereon previous to the workmen entering the mine, using a safety lamp where inflammable gas has been found within the preceding 12 months. He shall make a report of such examination in a book kept at the mine for that purpose. He shall mark with chalk upon the face of each working place so examined the number indicating the day of the month when the examination was made. If firedamp or any impure gas is found, or a place is otherwise unsafe, the fireman shall prevent miners and other workmen from entering such road or working place until the danger is

removed, and if necessary he shall withdraw the men from any portion or division of the mine which he considers to be in an unsafe condition, and the men shall be subject to his orders in this respect. Where falls of roof are found he shall cautiously examine such fall to ascertain if any firedamp or other gas is present, and report the condition of the same to the manager or overman. When examining a mine after the same has been closed for an unusual length of time, the fireman shall proceed with great caution and shall not go farther into the workings than his experience shall deem safe, before proper means are applied to restore the ventilation of the mine. He shall fence off, or cause to be fenced off, all places that are not actually working, and erect brattices where required, to convey air to the workmen. He shall report to the manager or overman any deficiency in the ventilation, or any violation of or failure to comply with the terms of the General Rules on the part of the miners or other workmen. He shall visit each working place in his district at least once a day for the purpose of seeing that the miners are keeping the roof and coal secure, and unless another person is specially appointed for that purpose he shall examine and superintend the firing of all shots as required in General Rule 9.

QUES. 10.—What are the duties of the bottom or signal man? What signals are given by him to the surface, as provided by Special Rules?

Ans.—He shall prevent as far as possible any violation of the Rules that may come under his notice, and report the same to the manager or overman. He shall regulate the number of men ascending on the cage at one time, and attend to the proper loading of material. He shall give and answer all signals at the bottom of the shaft for the movement of the cage, examine the signal apparatus, cages, and guides in the shaft, and the tubs used in the pit, and report their condition to the manager. He shall ring once for the ascent of the cage whether loaded with material or empty. When men are to descend he shall ring three times in rapid succession, and after receiving the response from the surface that all is ready, he shall then ring once for the ascent of the cage. He shall ring once to stop the cage when in motion, and twice for the engine to be reversed and the cage returned to the bottom of the shaft.

QUES. 11.—What is stated in the General Rules as regards the ventilation of mines?

Ans.—Rule 1 requires that an adequate amount of ventilation shall be constantly produced in every mine to dilute and render harmless the noxious gases that may exist therein. Rule 2 specifies that this ventilation shall not be less than 100 cubic feet of pure air per minute for each man, boy, horse, or mule employed in the mine, and as much more as the inspector may direct, and shall sweep the face of each working place. The Rule also requires that the mine shall be so divided with respect to its ventilation, that there shall be not more than 70 men in any one district, which shall be supplied with a separate current of fresh air. All intake air shall travel free from all stagnant water, stables, and old workings, and every place shall be bratticed to within 4 yards of its face. The inspector may require that two doors be used instead of one at any point upon the main road, in order to prevent the derangement of the ventilation of the mine while boxes are passing.

QUES. 12.—State regulations and requirements for the use of safety lamps and naked lights in mines as provided in General Rules.

Ans.—General Rule 8 requires that no lamp or light other than a locked safety lamp shall be used in any working approaching any place where there is likely to be an accumulation of explosive gas, and that wherever safety lamps are required each lamp shall be examined by a competent person appointed for that purpose, immediately before it is taken into the mine, to ascertain if the lamp is secure and securely locked. And no lamp shall be unlocked by any person without due authority, and no person without such authority shall have in his possession in any part of a mine where safety lamps are required, any key or contrivance for unlocking a safety lamp, or any lamp or apparatus of any kind for striking a light. The Rule also prohibits the use of naked lamps upon any part of a return current from a portion of the mine where safety lamps are required.

SURVEYING AND LEVELING.

QUES. 1.—If a triangle has one angle of $65^{\circ} 10'$, and another angle of $70^{\circ} 25'$, what is the size of the third angle?

Ans.— $180^{\circ} - (65^{\circ} 10' + 70^{\circ} 25') = 44^{\circ} 25'$.

Hence, the third angle of the triangle is $44^{\circ} 25'$.

QUES. 2.—On a plan the scale of which is six chains to an inch, how many acres would one inch square represent?

Ans.—The area is $6 \times 6 = 36$ square chains, or since 10 square chains make one acre, $\frac{36}{10} = 3.6$ acres.

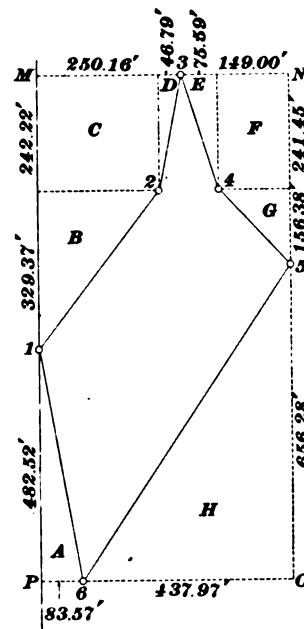
QUES. 4.—Find the length in feet of an arc of $40^{\circ} 33'$, the radius being 11 ft. 6 in.

Ans.—The circumference of a circle whose radius is 11 ft. 6 in. is $2 \times 3.1416 \times 11.5 = 72.2568$ ft. The length of an arc of this circumference containing $40^{\circ} 33'$ would therefore be,

$$\frac{60 \times 40 + 33}{360 \times 60} \times 72.2568 = \frac{2,433}{21,600} \times 72.2568 = 8.139 \text{ ft.}$$

QUES. 5.—If the horizontal angles and distances of a survey are as follows:

Course.	Bearing.	Distance (feet).
1-2	N $37^{\circ} 13'$ E	413.6
2-3	N $10^{\circ} 56'$ E	246.7
3-4	S $17^{\circ} 23'$ E	253.0
4-5	S $43^{\circ} 37'$ E	216.0
5-6	S $33^{\circ} 43'$ W	789.0



how far north or south and east or west of Sta. 1 is Sta. 6?

Calculate the course and distance from Sta. 1 to Sta. 6.

Ans.—The traverse of this survey is as follows:

Course.	Distance (feet).	Latitudes.	Departures.
N $37^{\circ} 13'$ E	413.6	+ 329.37	+ 250.16
N $10^{\circ} 56'$ E	246.7	+ 242.22	+ 46.79
S $17^{\circ} 23'$ E	253.0	- 241.45	+ 75.59
S $43^{\circ} 37'$ E	216.0	- 156.38	+ 149.00
S $33^{\circ} 43'$ W	789.0	- 656.28	- 437.97
Totals		+ 571.59	+ 521.54
Totals		- 1054.11	- 437.97
Differences		- 482.52	+ 83.57

In the above traverse north latitudes are marked plus, and south latitudes minus; east departures are marked plus, and west departures minus. Sta. 6 is therefore 482.52 feet south and 83.57 feet east of Sta. 1.

To find the bearing of the course from Sta. 1 to Sta. 6, divide the difference in departure by the difference in latitude. Thus, $\frac{83.57}{482.52} = .17319$, which is the tangent of the angle the course 1-6 makes with the meridian. The bearing of the course is, therefore, $S 9^{\circ} 50' E$. The length of the line 1-6 is found by dividing the difference in departure by the sine of the bearing of the course 1-6. Thus, $\frac{83.57}{\sin 9^{\circ} 50'} = \frac{83.57}{.1707} = 489.7$ ft.

QUES. 6.—Plot the following survey, and calculate its area. Draw a line from the terminal point, to the place of commencement, and give the bearing and distance of the same.

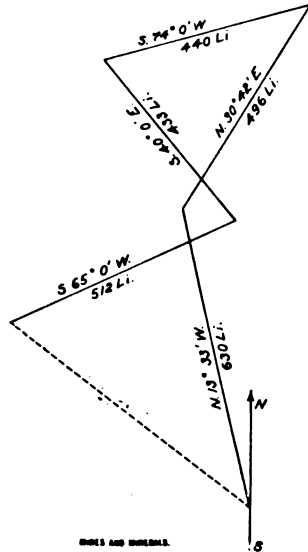
Course.	Distance (links).
N $13^{\circ} 33'$ W	630
N $30^{\circ} 42'$ E	496
S $74^{\circ} 00'$ W	440
S $40^{\circ} 00'$ E	433
S $65^{\circ} 00'$ W	512

Scale one chain to one inch.

Ans.—Following is the calculated traverse of the survey,

north latitudes being marked +, and south latitudes —; and, likewise, east departures +, and west departures —, as in question 5.

Bearing.	Distance (links).	Latitudes.	Departures.
N 13° 33' W	630	+ 612.47	— 147.60
N 30° 42' E	496	+ 426.49	+ 253.23
S 74° 00' W	440	— 99.23	— 346.05
S 40° 00' E	433	— 331.70	+ 278.33
S 65° 00' W	512	— 216.38	— 464.03
Totals		+ 1038.96	— 957.68
Totals		— 647.31	+ 531.56
Differences		+ 391.65	— 426.12



To find the bearing of a line drawn from the last point of the survey to the first point of the same, we have $\frac{426.12}{391.65} = 1.0881 = \tan 47^\circ 25'$, and the bearing is S 47° 25' E. The length of this line is $\frac{426.12}{\sin 47.25} = \frac{426.12}{.73629} = 578.74$ links. Inasmuch as the survey lines cross each other, it is impracticable to calculate the area of this survey.

QUES. 7.—Fill in and work out the following levels:

Backsight.	Foresight.	Distance (chains).
3.50	4.65	4.60
4.10	10.85	7.80
5.04	9.25	11.60
3.84	12.91	15.20
	7.65 Intermediate sight	
4.12	3.92	21.00
12.96	3.03	27.00

ANS.—Assuming a bench-mark elevation of 100 feet above datum we have:

Sta.	B. S.	H. I.	F. S.	Elevation.
B. M.				100.00
1	3.50	103.50	4.65	98.85
2	4.10	102.95	10.85	92.10
3	5.04	97.14	9.25	87.89
4	3.84	91.73	12.91	78.82
			7.65	84.06
5	4.12	82.94	3.92	79.02
6	12.96	91.98	3.03	88.95

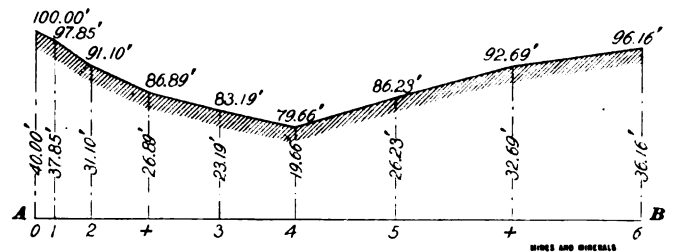
QUES. 8.—Plot the following notes of a level book:

Back Sight.	Intermediate Sight.	Fore Sight.	Rise.	Fall.	Reduced Levels.	Distance (Chains).
4.50		6.65				4.60
5.10		11.85				7.80
6.04	10.25					11.60
		13.95				15.20
5.12		8.65				17.00
11.49		4.92				21.00
13.96	7.50					25.00
		4.08				27.00

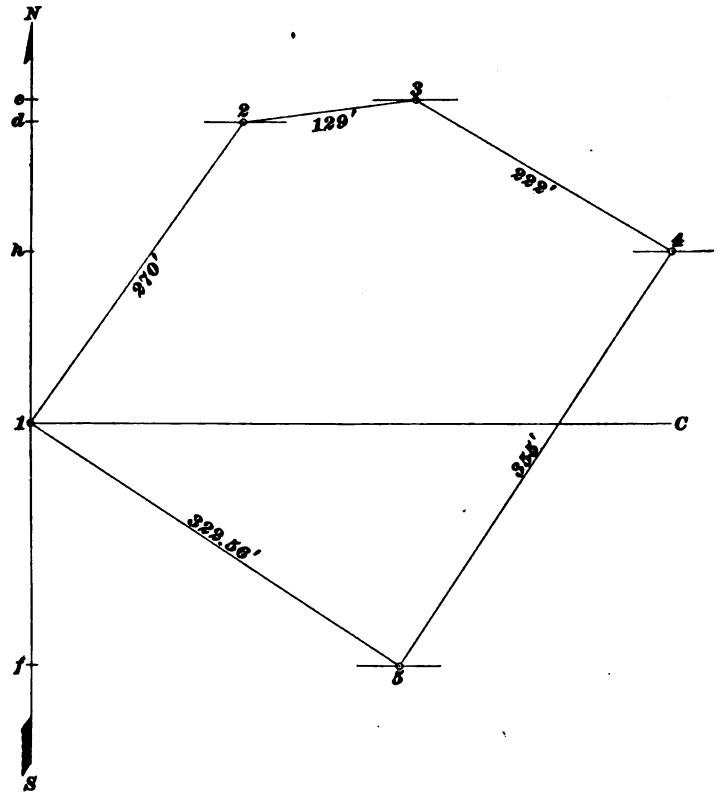
ANS.—Assuming an elevation of the starting point (Sta. 0) of 100 feet above datum, we have:

Sta.	B. S.	Rod.	F. S.	Rise.	Fall.	Elevations (Feet).	Distance (Chains).
0						100.00	
1	4.50		6.65		2.15	97.85	4.60
2	5.10		11.85		6.75	91.10	7.80
+	6.04	10.25			4.21	86.89	11.60
3			13.95		7.91	83.19	15.20
4	5.12		8.65		3.53	79.64	17.00
5	11.49		4.92	6.57		86.23	21.00
+	13.96	7.50		6.46		92.69	25.00
6			4.08	9.93		96.16	27.00

The line *AB* is a reference line at an assumed elevation of 60 feet above datum, for the purpose of drawing the profile. To construct the profile, subtract the elevation of the reference line from the elevation of each station and measure this distance up from the reference line.



struct the profile, subtract the elevation of the reference line from the elevation of each station and measure this distance up from the reference line.



QUES. 9.—Plot the following compass survey, to a scale of 100 feet to one inch.

Station.	Bearing.	Distance (Feet).
1 to 2	N 35° E	270
2 to 3	N 83 1/2° E	129
3 to 4	S 57° E	222
4 to 5	S 34 1/2° W	355
5 to 1	N 56 1/2° W	322.58

ANS.—The above plot is reduced to a scale of 142 feet to one inch.

QUES. 3.—How would you carry a transit survey down a perpendicular shaft?

ANS.—Assuming that there is but one shaft which can be used

for the purpose mentioned, the usual method is to suspend two or more plumb-bobs in the shaft from points previously located over the mouth of the shaft at the surface. In the location of the surface points over the mouth of the shaft, the bearings of the lines joining the several points are found by connecting these points with the surface survey and their lengths measured. Bobs are then suspended in the shaft from each of these points, and having been lengthened to a position close to the bottom of the shaft, tubs of water or oil are arranged in which the suspended bobs are placed so as to reduce their vibration to a minimum. Whether two bobs or more are employed it is always an advantage to connect the bobs at the bottom of the shaft by light sticks in which saw cuts have been made to correspond to the distances between the several points at the top of the shaft. These sticks are placed in position at the foot of the shaft so as to connect the several bobs into one hanging system, which greatly reduces the independent vibration of the bobs and facilitates the work. When the bobs have come to rest sufficiently, a transit set up in the entry at the bottom of the shaft is brought into line with any two of the suspended bobs or plumb-lines. The distance is measured from the transit to one of the bobs, and by referring to the notes of the surface location the bearing of this line from the bobs to the transit is obtained, and the exact location of the transit calculated. The mine survey is then extended from this point into the mine, and is thus referred to the same meridian and starting point as the surface survey.

Another method of carrying a surface survey down a perpendicular shaft is by arranging a transit at the shaft head in such a position as to sight down the shaft. A transit for this purpose must be provided with a side telescope by means of which a perpendicular line of sight can be had. Two points are thereby established at the foot of the shaft with great accuracy. The line joining these two points and having the same bearing with the surface line is then extended into the mine.

Report of the Girard Estate.

The report of Major Heber Thomson, Engineer of the Girard Estate, Pottsville, Pa., for 1900 shows that during that year the coal consumed in operating the collieries forming part of the Girard Estate, apart from that consumed by the washeries, was 172,082 tons, which is 17.42 per cent. of their shipment to market. The largest percentage of its shipment consumed in operating by any colliery in active operation was 20.25 per cent., the smallest 9.50 per cent. Coal consumed in operating the washeries was 4.78 per cent. of their shipment to market.

The average royalty received upon the 1,269,443½ tons of coal produced in the year 1900 was 24.79 cents per ton. The average royalty upon the 1,092,357 tons shipped to market from collieries and washeries was 28.81 cents per ton. Upon the 987,650 tons of freshly mined coal shipped by collieries, apart from the washeries, the average royalty was 30.76 cents per ton. Upon the 104,707 tons of coal obtained from culm banks and shipped by washeries the average royalty was 10.43 cents per ton.

The following were the percentages of the various sizes of anthracite coal upon the Girard Estate, shipped during 1895 and 1900.

	1900	1895
Lump	40%	3.60%
Steamboat	3.36%	8.57%
Broken	10.65%	10.42%
Egg	10.22%	10.90%
Stove	13.57%	17.15%
Chestnut	19.21%	20.81%
Total large	57.41%	70.95%
Pea	13.98%	11.51%
Buckwheat	21.10%	16.54%
Rice	7.51%	1.00%
Total small	42.59%	29.05%
Total shipment	100.00%	100.00%

These percentages show a material increase in the percentage of buckwheat and rice coal shipped, a slight increase in the percentage of pea coal, and quite a decided decrease in chestnut and larger sizes. A comparison of these percentages with those given in the report for the year 1895 shows the great change which has taken place in this respect in the preparation of anthracite coal, due largely to the enormous amount of small coal at present being washed from old culm banks.

At the Lucy furnaces of the Carnegie Steel Co. a novel plant has been installed to free the air of its moisture before the blast is blown into the furnace. A refrigerating plant has been installed and the moisture will be absorbed on coils of pipe, through which brine will be forced, as is done in cold storage houses. The moisture will freeze on the outside of the pipes, and the blast will pass to the hot blast stoves with all or nearly all of its moisture extracted, thus giving a much greater efficiency to the coke used in the furnace. This experiment of the Carnegie Company is being watched with interest by all blast furnace men throughout the United States.

PRIZE CONTEST.

Prizes Given for the Best Answers to Questions Relating to Mining.

For the best answer to each of the following questions, the value of \$1 in any of the books in our book catalogue, or six months' subscription to *MINES AND MINERALS*.

For the second best answer to each question, the value of 50 cents in any of the books in our book catalogue, or three months' subscription to *MINES AND MINERALS*.

Both prizes for answers to the same question will not be awarded to any one person.

Conditions.

First—Competitors must be subscribers to *MINES AND MINERALS*.

Second—The name and address in full of the contestant must be signed to each answer, and each answer must be on a separate paper.

Third—Answers must be written in ink on one side of the paper only.

Fourth—"Competition Contest" must be written on the envelope in which the answers are sent to us.

Fifth—One person may compete in all the questions.

Sixth—Our decision as to the merits of the answers shall be final.

Seventh—Answers must be mailed to us not later than one month after publication of the question.

Eighth—The publication of the answers and names of persons to whom the prizes are awarded shall be considered sufficient notification. Successful competitors are requested to notify us as soon as possible as to what disposal they wish to make of their prizes, and to mention the numbers of the questions when so doing.

Ninth—In awarding prizes, other things being equal, a carefully written and arranged answer will be given the preference.

Competition Questions for July.

Ques. 692.—To Control a Spouting Oil Well.—Describe the means to be employed to bridle and control a spouting well of oil that has just been struck by a bore hole 6 inches in diameter. The oil is spouting from the hole in a column 100 feet high.

Ques. 693.—Rooms Turned at an Angle with the Haulage Road.—Room No. 10, turned off from a given haulage road makes an angle of L 67° 30' with the road. At station 200 a distance of 12.5 feet inside of the sight line of room No. 10, the haulage road deflects R 13° 15'. The rooms are driven 9 yards wide, with 13-foot pillars between them. Calculate the distance, center to center, between the rooms outside of No. 10, and inside of No. 11 room; also the distance from station 200 to the sight line of room No. 11.

Ques. 694.—Wedging Mine Timbers.—Explain why a timber-set should not be wedged either at the center of the cross-beam or immediately above the legs of the framing. In setting post timber, should hard or soft wedges be used, and why?

Ques. 695.—Hitches for Stulls or Cross-Beams.—Where it is desirable to obtain all the strength possible for a given stull or cross-beam, what advantage may be taken in cutting the hitches, and in what proportion will the strength of the beam be increased by so doing?

Ques. 696.—Cost of Sinking and Timbering a Shaft.—Make an estimate of the cost of sinking and timbering a shaft 8 ft. × 16 ft. in the clear, in the following strata:

Drift	20 feet	
Soft shale	35 feet	
Sand	8 feet	Flow=2 inches
Sandrock, pervious	30 feet	
Limestone	50 feet	
Weak shale	60 feet	
Quicksand and marl seams	80 feet	Flow=6 inches
Conglomerate	25 feet	
Hard sandrock	42 feet	
Slaty limestone with slips	30 feet	
"Bat," or drawslate	20 inches	
Coal	34 inches	
Clay parting	8 inches	
Coal	22 inches	
Underclay	30 inches	

The flow of water in the above section is given in miners' inches. The estimate will include all material, tools, and labor necessary for the sinking and timbering of the shaft and sump; this will include a temporary headframe or derrick with hoisting sheave, small sinking engine, ropes, drum, sinking buckets, trucks, rails, etc. The shaft is divided into two hoisting compartments and manway, and provided with wooden guides. Assume the material to be dumped into a ravine close to the shaft; also assume prices for all labor and material f. o. b. cars at mine station, one mile from shaft location. The estimate will include also the cost of drayage of material from the station to

the shaft. The water supply will be obtained by the construction of a small dam near the shaft, and piping to the engine. The sinking may be done during the spring and summer season.

QUES. 697.—*Relative Strength of Square and Round Timber.*—What relation exists between the side of a cross-beam of square timber and the diameter of a cross-beam of round timber of equal spans and sustaining equal loads?

QUES. 698.—*Driving Sheave of an Endless-Rope Haulage.*—In the use of a single driving sheave in an endless-rope haulage, what means are adopted to prevent the binding or chafing of the ropes running on and off the sheave?

QUES. 699.—*Diffusion of Mine Gases.*—(a) Why does marsh gas (CH_4) diffuse more rapidly into the air current than carbonic-acid gas (CO_2)? (b) In a close place, where the ventilation is poor, is there any limit to the diffusion of marsh gas into the atmosphere?

Answers to Questions Which Appeared in the May and Previous Numbers and for Which Prizes Have Been Awarded.

QUES. 664.—*Locating Error in a Survey.*—Following are notes of a surface survey enclosing a plat of ground.

Sta.	Angle.	Distance (Feet).	Sta.	Remarks.
1	R 102° 30'	250	2	B. S. = Sta. 5.
2	R 54° 55'	500	3	
3	R 85° 25'	825	4	
4	R 78° 50'	242	5	
5	R 98° 20'	1,333	1	

As this survey does not close there is evidently an error in the work or notes. Explain how you would proceed to locate this error in the quickest manner possible, assuming that the work has been done carefully throughout, and that therefore the trouble arises from a single error, at some point of the survey, instead of several errors.

Ans.—The sum of the deflection angles being in this case 360°, the error is clearly not in arc but in distance. To locate the error assume the backsight 1-5 as a meridian, and calculate the azimuth and bearing of each course. Then traverse the survey by calculating the northing or southing and the easting or westing of each several course; thus,

Sta.	Angle.	Azi-muth.	Bearing.	Distance (Feet).	N.	S.	E.	W.
1	102° 30'	102° 30'	S 77° 30' E	250		54.11	244.07	
2	54° 55'	157° 25'	S 22° 35' E	500		461.66	192.01	
3	85° 25'	192° 50'	S 12° 50' W	825		804.39		133.25
4	78° 50'	268° 40'	S 86° 40' W	242		14.07		241.59
5	98° 20'	360° 00'	Due North.	1,333	1,333.00			
Totals,					1,333.00	1,334.23	486.08	424.84
Differences,						49.77	11.24	

[In a closed survey, if no error exists, the northings will balance the southings and the eastings the westings. Any difference or lack of balance indicates the error of the survey.] Assuming that the error has occurred in a single course, if we divide the difference in easting and westing by the difference in northing and southing the quotient will be the tangent of the course in which the error occurred; thus, $\frac{11.24}{48.77} = .23047$

which is the tangent of 12° 59', indicating the error to be in the course S 12° 50' W, the difference of 09' being due to the usual small error in closure. To find the amount of error divide the error in westing by the sine of the bearing of the above course;

thus, $\frac{11.24}{\sin 12^\circ 50'} = \frac{11.24}{.22212} = 50.6$ ft., making the true distance from 3 to 4, $825 + 50.6 = 875.6$ ft. Or again, by dividing the error in southing by the cosine of the bearing of the course we obtain $\frac{48.77}{\cos 12^\circ 50'} = \frac{48.77}{.97502} = 50.0$ ft., making the true distance

from 3 to 4, $825 + 50.0 = 875.0$ ft., a more probable error than the former. When this correction has been made the survey will close with an error of only 0.02 in northings, and 0.11 in eastings.

A rapid method of obtaining the same result consists in plotting the survey with a protractor, and taking off the course between the two locations of Sta. 1 with the protractor and scaling the distance.

Since, excluding blunders, there is almost always a small error in closure, the calculated course rarely agrees exactly with any one course and may merely indicate the blunder to lie on any one of several nearly parallel courses. This method should be used in practice merely as a guide, and the exact error ascertained by remeasuring such courses as are indicated. The suspected course should always be remeasured, for a combination of two or more errors may point to a supposed error in a certain course, its correction in the office giving a good closure, but which on remeasurement may be found correct.

A. B. JESSUP, Centralia, Pa.

Second Prize.—C. DRINKWATER WRAY, Lillooet, B. C., Can.

QUES. 676.—*Inversion of a Vein.*—What is meant by inversion of a vein, and how is the fact of its inversion determined practically?

Ans.—[The inversion of strata signifies primarily the bending of strata upon themselves in such manner as to reverse the apparent order of succession in the strata.] The inversion of a vein, bed, or seam so alters the position of the strata that the lower or earlier strata appear to be the upper or more recent ones and vice versa. Such an inversion may often be seen where highly contorted beds, outcrop in the cliffs; as, for example, in some parts of the Alps, where such beds may be observed bent into the form of an S or Z in the precipitous sides of the mountains. The inversion of beds is occasionally observed in coal mining, as in Belgium, [France], and the Southwest of Ireland, where beds of coal are sometimes found with the "coal-thill" uppermost and the "coal roof" undermost. In a disturbed part of the South Staffordshire coal field, the same bed of coal was passed through three times in succession in the same vertical shaft, first in its right position, then inverted, and again right side uppermost. It must accordingly have been bent into the shape of the letter S or Z.

[The fact of inversion is determined practically from the order of succession in the strata as being reversed, downward instead of upward.]

T. WATSON, 3 East Hedley Hope, Tow Law, Durham, Eng.

Second Prize.—C. D. WRAY, Lillooet, B. C., Can.

QUES. 677.—*Size and Inclination of Screens.*—Give the proper size and inclination of lump coal screens for bituminous coal, and state how the inclination should be modified where the coal is wet. Give the size and inclination of nut coal screens for bituminous coal. How is this inclination affected in the case of shaking screens? What is the proper inclination for a revolving nut screen?

[This question still remains open. In stating the size of a screen, not only the size of the screening surface but the size of screen bars and the width of openings between them should be given.—EDITOR.]

QUES. 678.—*Self-Acting Inclines in Steep Pitching Seams.*—Explain the operation of the self-acting incline for lowering material from the working face to the gangway in a steep pitching seam where for some reason it is desired to use inclines instead of chutes.

Ans.—In steep pitching seams when the coal breaks easily it is often desirable to lower it from the working face to the gangway by gravity, and for this purpose a self-acting incline called a "jig" is usually employed. This consists of an incline so arranged that a balance car or weight is pulled up the incline by the descending loaded car or cars and this in turn descending draws the empty car or cars up the incline to the working face. Sometimes the jig weight or balance car runs upon a narrow-gauge track between the car rails; at other times it is made to run upon an entirely separate track in a parallel opening. The jig weight usually consists of a heavy cast-iron box, on low wheels, and when made to travel between the car rails is built low enough to allow the cars to pass over it. Its weight is made equal to half the sum of the weights of the empty and loaded trips. The result is, that when a loaded trip descends, half the weight of the coal it carries and the weight of the car or cars is balanced by the weight of the jig, while the other half of the weight of the coal exerts the gravity pull that raises the jig. The excess of the weight of the jig over the weight of the empty car or cars which excess is equal to half the weight of the coal raised, now performs the work of raising the empty trip.

J. E. HOPKINS, Ramey, Pa.

Second Prize.—C. D. WRAY, Lillooet, B. C., Can.

QUES. 679.—*Size of Shaft Pillars.*—(a) What size of pillar should be left for the support of a shaft 100 yards in depth, when the thickness of the seam is 5 feet? The coal is hard but the bottom is soft and heaves readily. The roof is a hard slate. (b) What size of pillar should be left when the thickness of the seam is 10 feet, the other conditions remaining the same?

Ans.—Practically speaking, the size of shaft pillars is best determined by experience in the district in which the shaft is sunk. But assuming that this is a new territory, a good rule to apply is that given by Mr. R. J. Foster, see General Arrangement of Shaft Bottoms, page 330, MINES AND MINERALS, February, 1901. The rule proposed by Mr. Foster has reference to the thickness of

the seam as well as the depth of the shaft and is as follows: Radius of shaft pillar = $3 \times \sqrt{\text{depth of shaft} \times \text{thickness of seam}}$ (all in feet). Substituting the given values in this formula we have for the radius of the shaft pillar $R = 3 \times \sqrt{3 \times 100 \times 5} = 116.2$, say 117 ft. When the thickness of the seam is 10 feet we have $R = 3 \times \sqrt{3 \times 100 \times 10} = 164.3$, say 165 ft. Now since the floor is soft and heaves readily, it may be better to increase the above results 50%. We would then have (a) $117 \times 1.50 = \text{say } 175 \text{ ft.}$, and (b) $165 \times 1.50 = \text{say } 247 \text{ ft.}$ [Unless the bottom is exceedingly troublesome this is too large an increase; the first results obtained above would ordinarily prove sufficient.]

J. E. HOPKINS, Ramey, Pa.

Second Prize.—JAMES WARDLAW, Everson, Pa.

QUES. 680.—*Water Gauge Readings at the Top and Bottom of Shaft.*—(a) If the water gauge showed a reading of 3 inches at the fan drift at the top of a shaft, while the reading taken between the intake and return airways at the foot of the shaft was $3\frac{1}{2}$ inches, what would this indicate in reference to the power concerned in the movement of the air current? (b) If the fan was making 50 revolutions per minute when the above readings were taken, and its speed be now increased to 75 revolutions per minute, what readings would you then expect to obtain at each of these points, respectively, at the top and the bottom of the shaft? (c) In what proportion would the quantity of air in circulation be increased in this case?

[Most of the answers to this question have ignored the fact that there is here presented an instance of what we may call a false water gauge reading, as explained in the article "False Water Gauge Readings," page 136, MINES AND MINERALS, October, 1900. In other words the water gauge reading observed at the top of the shaft does not in this case correctly represent the mine resistance. The answers that did consider this fact made other serious errors. We hope for better results upon a second trial. The question is still open.—Editor.]

QUES. 681.—*Drilling Prospect Holes.*—In a mountainous region where the general inclination of the strata is 60° , it is desired to drive a drainage tunnel into the sidehill to intersect the main slope of a mine at a point 1,500 yards down the slope from its mouth. Before starting the work, however, it is proposed to prospect the strata by drilling in order to ascertain approximately the probable cost of driving the tunnel. Where should the necessary hole or holes be drilled to obtain this information? Would it be practicable to drill a nearly horizontal hole across the strata at the proposed site of the tunnel, and if not, why not?

Ans.—Vertical prospect holes should be drilled (Fig. 1) from the surface, on the line of the proposed tunnel, say 300 feet apart

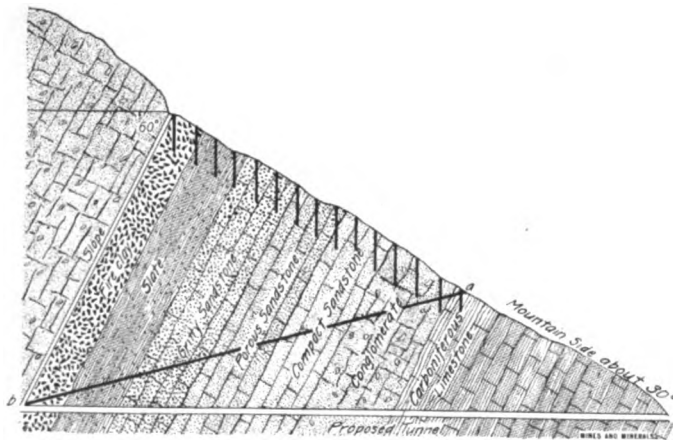


FIG. 1.

and of such a depth as to test all the ground between the holes; in this case [the holes being 300 feet apart measured on a hillside of 30° , $\sin 30^\circ = .5 =] 600 \text{ ft.}$ An inclined hole drilled across the strata, say from a to b , Fig. 1, would cost more on account of its length and position than the requisite number of short vertical holes notwithstanding the total distance drilled is greater in the latter case. [To calculate the number and depth of vertical holes required to prospect all the strata cut by such tunnel,

- let,
- a = inclination of strata,
 - β = inclination of hillslope,
 - l = length of slope to intersection of tunnel (ft.),
 - d = horizontal distance between holes (ft.),
 - n = number of holes required,
 - x = depth of each hole to cut intervening strata.

Then,
$$n = \frac{l \sin a}{d \tan \beta},$$
 and
$$x = d (\tan a + \tan \beta).$$
 To find the total distance drilled, multiply the depth of hole by the number of holes; thus,

$$nx = l \sin a \left(1 + \frac{\tan a}{\tan \beta}\right). \text{—EDITOR.]}$$

JOS. VIRGIN, Inman, Va.

Second Prize.—R. ZERUBABEL VIRGIN, Punxsutawney, Pa.

QUES. 682.—*Size of Mine Timber.*—If timber 6 inches in diameter has been used successfully for the collars or cross-beams in entries 8 feet wide, what should be the diameter of the cross-beams in the same mine for partings, where the clear width of the road is 14 feet? If 6-inch timber is used at the working face where the posts are $4\frac{1}{2}$ feet in length, what should be the diameter of the posts on the main roadways of the mine where the height is 6 feet in the clear?

Ans.—The load round timber cross-beams will support varies as the cube of the diameter of the timber and inversely as its length (Prize Contest Ques. 613, page 170, MINES AND MINERALS, November, 1900). Let us reason as follows: If an 8-foot collar will support a load of 1 ton, a 14-foot collar of the same diameter will support $\frac{1}{2}$ ton, but under the conditions the longer collar is required to support $\frac{1}{8}$ ton. Then, since for the same length the load a collar will support varies as the cube of its diameter, the diameter of a collar to support any given load will vary as the cube root of the load. Hence, in this case we have $\frac{1}{8} : 1 :: \frac{1}{8} : \left(\frac{1}{8}\right)^{\frac{1}{3}} :: 6 : x$, and for the diameter of the 14-foot collar, $x = 6 \sqrt[3]{\left(\frac{1}{8}\right)^{\frac{1}{3}}} = 8.7 \text{ in.}$ The diameter of prop timber (posts) varies approximately as the cube root of the length of the post. Hence, in a mine where $4\frac{1}{2}$ -foot room timber having a diameter of 6 inches is employed,

the diameter of 6-foot main roadway timber should be $6 \sqrt[3]{\frac{6}{4.5}} = 6.6 \text{ in.}$ [This rule is taken from Mauchline. In this connection see Article Principles Relating To Post Timber, which will appear in next issue.—Editor.]

J. E. HOPKINS, Ramey, Pa.

Second Prize.—A. B. Jessup, Centralia, Pa.

[The reasoning above though attaining correct results is not complete or clear. Perhaps the following explanation will make the matter plain. Since, *For the same diameter, the load round timber cross-beams will support varies inversely as the length of the timber,* a 14-foot beam will evidently support but $\frac{1}{2}$ of the load held by an 8-foot beam of equal diameter; but under the conditions the longer beam must support a load $\frac{1}{8}$ times that held by the shorter beam. The load increases in the ratio $\frac{1}{2} : \frac{1}{8}$, or clearing of fractions by multiplying the ratio by each denominator $8^2 : 14^2$, or $(\frac{1}{8})^2$. But since, *For the same span, the load round timber cross-beams will support varies as the cube of the diameter of the timber, or the diameter varies as the cube root of the load,* the diameter of the 14-foot beam must increase as the

cube root of above ratio or as $\sqrt[3]{\left(\frac{1}{8}\right)^2}$; or $d_2 = d_1 \sqrt[3]{\frac{1}{2}}$ and substituting values we have $x = 6 \sqrt[3]{\left(\frac{1}{8}\right)^2} = 8.7 \text{ in.}$ —EDITOR.]

QUES. 683.—*Surveying With a Vernier Compass.*—Explain how you would establish a reliable magnetic meridian where iron is used upon the roadways, supposing that you have a vernier compass at your disposal.

Ans.—To establish a reliable magnetic meridian upon a road where iron is used, first take the compass to some room or disused road where the rails have been taken up and there is no iron to attract the needle. Level the compass; then after clamping the vernier at zero and when the needle has come to rest, turn the compass so that the needle will point to zero and clamp the spindle firmly in this position, the line of sight being then in the magnetic meridian. Now, send a light forward in the direction desired, and having the compass clamped to the spindle, loosen the clamp to the vernier plate and sight the compass to the forward light, and note the reading of the vernier. Then take the compass forward to the station where the light was held, set it up and sight back to the last station, taking care that the vernier reads the same as when the forward sight was taken, and again clamp the spindle. Now loosen the vernier clamp and turn the compass so as to bring the vernier back to zero, and the line of sights will again indicate the magnetic meridian. By continuing the above method a correct magnetic meridian may be carried to any part of the mine. The vernier being brought to zero, the sights will always be in the magnetic meridian, and if no iron is near to attract the needle, the needle and vernier should always have the same reading.

JOS. S. QUIGLEY, Broad Cove Mines, C. B., Can.

Second Prize.—C. D. WRAY, Lillooet, B. C., Can.

NEW INVENTIONS.

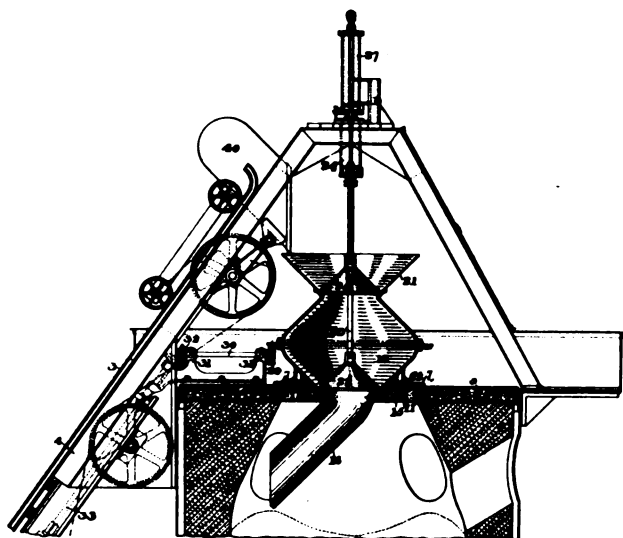
EDITED BY H. M. LANE, M. E.

Complete specifications and drawings for any of the following patents can be obtained from the COMMISSIONER OF PATENTS, WASHINGTON, D. C., at the following rates:

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BLAST-FURNACE CHARGING APPARATUS.

No. 670,322. JULIAN KENNEDY, PITTSBURG, PA. *Patented March 19, 1901.* The invention is designed to provide an automatic charging apparatus which will distribute the material charged into the blast furnace as desired by the operator. It is further intended to apply the apparatus to existing furnaces, in order to reduce the quantity of fine ore carried out with the escaping gases, and also to effectually seal the top of the furnace against leakage of gas. A sectional side elevation, of the upper portion of a blast furnace provided with the charging apparatus is shown. It represents an inclined track 3, and framework 4; for charging car 40. The car dumps the ore automatically into the hopper 21; the bell 25 is lifted by the piston rod of a motive cylinder 27, and allows the ore to pass into the lower or main hopper 13. The bell 22 is next raised by the piston 23, of a motive cylinder 24, thus allowing the ore, etc. to pass through a depending spout 16, into the furnace. The entire hopper is turned by means of a pinion 29, secured to shaft 30, supported in bearings 31, at the top of the furnace and having bevel gear connections 32, with a shaft 33, which extends downwardly along the inclined track and is connected by bevel gearing with

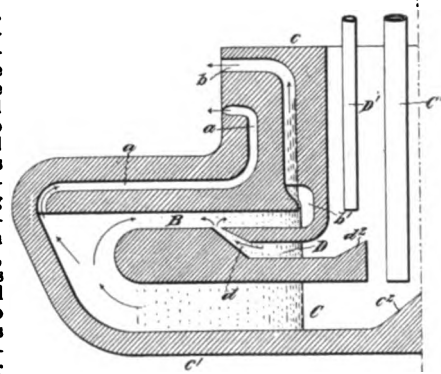


a vertical shaft which is actuated by a suitable motor on the surface. The furnace top is closed by an annular plate 5, provided with an annular bearing 11, having a ball-receiving recess containing a series of balls 12, thus affording a ball-bearing joint for the hopper. In order to seal the top of the furnace the top plate is supplied with water or other fluid or granular material, the flanges 7 of the plate holding this in a pool. The bearing 11, for the balls is perforated in its lower portion, so as to allow free communication of the fluid therethrough and extended down to give with flange 16, a double seal for the main-hopper connection. The ports for the explosion doors are situated with the doors in the top plate and are not shown in the figure; they are provided, however, with vertical flanges to hold the pool of water in place.

ORE SEPARATOR.

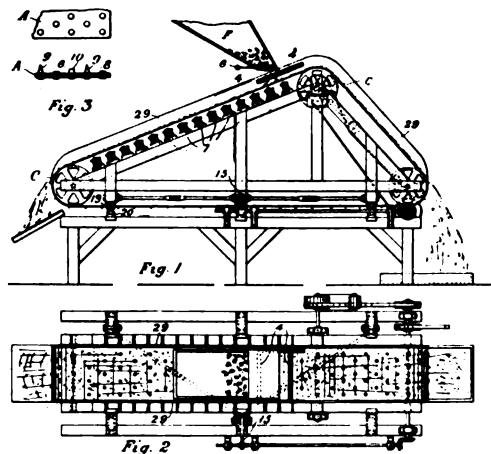
No. 671,573. F. H. A. WIELGOLASKI, CHRISTIANA, NORWAY. *Patented April 9, 1901.* The invention has relation to the separation of finely divided solids held in suspension in liquids. The difficulties in the mechanical separation of fine slimes from the liquid in which they are held in suspension are well known, and these difficulties are apparently due to the fact that the behavior of the finely divided particles is different from that of particles of measurable dimensions. Experiments have shown the impossibility of separating the constituents of slimes by centrifugal machines, as generally constructed, and this invention has for its object a method for effecting this separation by centrifugal action. It has been found that when a liquid holding in suspension a finely divided solid is simply caused to flow by centrifugal action in the direction in which the centrifugal forces are exerted the separation of the finer particles cannot be effected. However, if a liquid is caused to flow in a direction opposite to that in which the centrifugal forces are exerted, and caused to intercept the stream of liquid holding the finely divided solid in suspension, the particles of the solid are separated from such liquid and flow in opposition to the intercepting liquid in the direction

in which the centrifugal forces are exerted they can thus be effectually and readily separated in a centrifugal machine of proper construction. The accompanying figure shows a vertical section of a centrifugal machine constructed to carry out these ideas. The body or shell consists of a cylindrical upper portion *c*, and a circular lower portion *c'*. The lower portion *c'* has a considerably greater diameter than the upper portion *c*, the periphery of the said lower portion *c'* being inclined inwardly. In the lower portion *c'* is formed a circular chamber *C*, extending along the bottom from near the axis of the shell to its periphery, and thence in an upward direction and gradually widening into a trumpet-shaped cross-section and connecting with the discharge passage *a*, and a circular chamber *B*, the latter connecting with the vertical discharge passage *b*, the said passages *a* and *b* having their outlets in the periphery of the upper cylindrical portion *c* at different elevations, the outlet of passage *b*, being above the outlet of passage *a* and the outlet for the latter passage being constructed to form a nozzle having a comparatively narrow discharge opening. The pipe *C'* feeds into the chamber *C* a liquid, and the pipe *D'* feeds into the chamber *D* a liquid holding solid particles in suspension. In operation the liquid holding the substance in suspension is fed through pipe *D'* to chamber *D*, and another liquid, as water, for instance, is fed through the pipe *C'* to the chamber *C*, thus establishing antagonizing currents in chamber *B* whereby the centrifugal action forms a separation of the heavier particles, which particles move in the direction in which the centrifugal force is exerted to the periphery, and thence in a reversed direction, along the passage *a*, from which they are ejected, as the passage *a*, is very narrow as compared with the outer terminal of chambers *B* and *C*, and in view of the contracted outlet of said passage the flow of the liquid therethrough becomes sluggish as compared with the velocity of motion of the heavier solid particles, so that but a comparatively small proportion of liquid will find its way out of said passage and the bulk of the liquid and very light particles of solid, even if of greater specific gravity than water, will be ejected through the passage *b*.



MAGNETIC SEPARATOR.

No. 673,172. R. MACKNIGHT, NEW YORK CITY, N. Y. *Patented April 3, 1901.* The separator covered by this patent is shown in Figs. 1 and 2 and consists of a belt moving over pulleys *CC*, the left-hand portion of which is placed in an inclined position as shown. The ore is fed from the hopper *F* and may be acted upon by jets of water or air from the pipes *4*. The flow of ore is controlled by a gate *6*. Ore is prevented from moving off the plate by means of the guides *29* and is caused to feed downward by giving the entire frame carrying the rollers *CC* a shaking or oscillating motion, which is imparted by the shaking device shown at *15*. A series of cams is arranged at *19* and



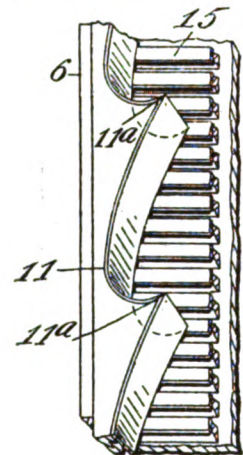
20 which give the left-hand end of the table a vertical motion, thus jarring and feeding the ore down the belt. The belt ascends against the ore and over the electromagnets *7*. The surface of the belt is provided with magnetic projections, as shown in detail by Fig. 3. These projections may have any of the forms shown at *8*, *9*, or *10*, *A* being the belt. These projections *8*, *9*, and *10*, composed of magnetic material, serve to conduct magnetic lines well up into the material and so attract and hold any magnetic particles. After the belt has passed the upper guide pulleys *C* it passes out of the magnetic zone and hence the magnetic material is discharged from the right-hand end of the machine.

In an alternate form the inventor claims the use of a belt composed of alternate strips of magnetic and non-magnetic material, in place of a non-magnetic belt carrying magnetic projections.

GOLD-SAVING, PLACER-MINING, AMALGAMATING, AND CONCENTRATING MACHINE.

No. 673,806. G. C. WALTERS, DENVER, COLO. *Patented May 7, 1901.*

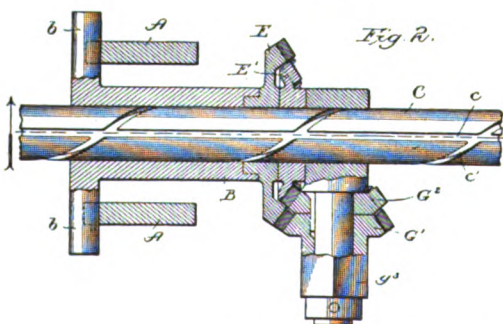
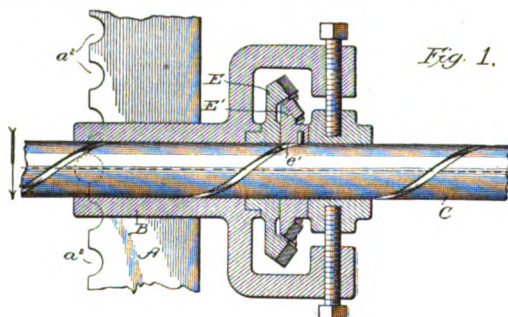
The device covered by this invention consists of a series of curved wings or projections which are attached to the sides of a sluice box or concentrating table so as to cause the material to form a series of eddies or whirlpools as it flows forward, thus thoroughly agitating the material and freeing any gold or heavy minerals from adhering clay or other material and collecting the values in the riffles or upon the surface of the concentrating table. The accompanying figure shows two of these projections, 11 being the piece attached to the side 6 of the sluice box above the riffles 15. The piece 11 has projections 11(a) as shown.



COAL DRILL.

No. 673,205. M. HARDSOOG, OTTUMWA, IA. *Patented April 30, 1901.*

The main feature of this patent consists of a method of rotating and feeding the drill forward. The drill frame and spindle are of the ordinary pattern, but the drill spindle *C* rotates in a casting *B*. This casting *B* carries trunnions *b* which engage the supporting frame or column *A*. The trunnions *b* come in contact with the semi-circular groove *a*². The spindle *C* has a helical groove *c*¹ and a straight groove *c*, as shown in Fig. 2. The gear *E* carries a straight spline working in a groove *c* so that when *E* revolves it will revolve the spindle *C* with it. The gear *E'* carries a feather fitting the helical groove as shown at *c*¹. If the gears *E* and *E'* revolve in unison, the spindle *C* will revolve but will not be fed forward. If the gear *E* is made to run faster or slower than the gear *E'* the spindle *C* will be fed forward or backward. In practice the gears are so proportioned that as the drill is rotated in the proper direction it is fed into the coal at the proper rate. This may be accomplished by making one gear rotate, say, 19 times while the other rotates 18 times. The result will be the spindle *C* will be fed forward a



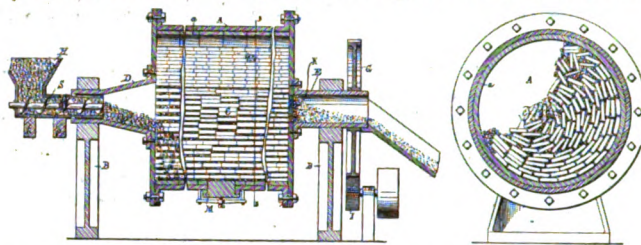
distance equal to the pitch of the helix. The gears *E* and *E'* are driven by the gears *G'* and *G*² which are operated by a crank placed on the square shank *g*².

APPARATUS FOR PULVERIZING ORES.

No. 673,195. J. K. CLARK, BUTTE, MONT. *Patented April 3, 1901.*

The device covered by this patent consists of an ordinary pulverizing barrel *A*, such as is used with an ordinary ball mill, but in place of using balls the inventor substitutes flat metal plates *C*, claiming great advantage from the increased rubbing surface. The shell *A* is provided with a lining *a*. The ore is fed in through a trunnion *D*, from the hopper *H*, by means of any suitable feeding device, as the screw *S*. The pulverized material discharges at the opposite end of the revolving cylinder through holes *K* into the trunnion *E*. The screen *K* prevents

the crushing blocks *C* from passing out. The entire barrel is supported on stands *B* and is driven by means of a gear *G* which meshes with a



suitable pinion *I*. A manhole *M* is provided for the introduction of the grinding blocks *C*. Fig. 2 is a section on the line 3, 3, Fig. 1.

PATENTS ISSUED DURING MAY AND NOT ILLUSTRATED.

- No. 673,423. Tooth for excavator buckets, A. M. Cupples, Tyrone, Pa.
- No. 673,425. Method of treating precious-metal-bearing ores, G. A. Duncan, Salt Lake City, Utah.
- No. 673,489. Ore-concentrating table, M. P. Willits, Nederland, Colo.
- No. 673,556. Iron notch for blast furnaces and means for plugging same, J. M. Hartman, Philadelphia, Pa.
- No. 673,607. Ore jigger, A. L. LeGrand, West Pittston, Pa.
- No. 673,717. Apparatus for boring tunnels, A. W. Manton, Wanstead, Eng.
- No. 673,768. Crushing roll, C. R. Fleming, Black Warrior, Ariz.
- No. 673,808. Concentrator, D. G. Wherry, Denver, Colo.
- No. 673,852. Tubbing for tunneling devices, W. S. MacHarg, Chicago, Ill.
- No. 673,856. Pulverizing mill, H. L. Kent, Brooklyn, N. Y.
- No. 673,928. Regenerative coke oven, F. W. C. Schniewind, New York, N. Y.
- No. 674,031. Process of making lead oxide, A. G. Fell, New York, N. Y.
- No. 674,057. Grinding or crushing rolls, T. A. Edison, Llewellyn Park, N. J.
- No. 674,104. Gas producer, W. Swindell, Allegheny, Pa.
- No. 674,159. Explosive and method of making same, J. E. Blomen and H. C. Aspinwall, Pompton Township, N. J.
- No. 674,169. Ore classifier, J. Klein, Desloge, Mo.
- No. 674,214. Concentrating jig, Samuel Orr, Leadville, Colo.
- No. 674,291. Explosive and method of making same, J. E. Blomen and H. C. Aspinwall, Pompton Township, N. J.
- No. 674,292. Method of making explosives, J. E. Blomen and H. C. Aspinwall, Pompton Township, N. J.
- No. 674,299. Amalgamating and concentrating apparatus, J. H. Lancaster, New York, N. Y.
- No. 674,353. Conveyer, F. C. Durant, Colorado Springs, Colo.
- No. 674,354. Ore-cooling device, F. C. Durant, Philadelphia, Pa.
- No. 674,491. Process of distilling wood for the manufacture of charcoal and saving of by-products, C. W. Bilfinger, Savannah, Ga.
- No. 674,533. Gold-separating machine, John Broyles, New Whatcom, Wash.
- No. 674,563. Apparatus for separating metals from their ores, W. A. R. Loose, Provo, Utah.
- No. 674,594. Process of treating ore, C. J. Best, Denver, Colo.
- No. 674,595. Furnace and device for treating ore, C. J. Best, Denver, Colo.
- No. 674,624. Amalgamator, J. Y. Byers, Descanso, Cal.
- No. 674,639. Method of treating ores, M. Seligsohn, Denver, Colo.
- No. 674,649. Furnace, S. A. Knapp, Hawthorne, Nev.
- No. 674,718. Roller mill for grinding and crushing, J. C. Wegerif, Leigh-on-Sea, Eng.
- No. 674,809. Process of treating zinc-bearing ores for obtaining zinc, etc., S. O. Cowper-Coles, London, Eng.
- No. 674,881. Rock-drilling machine, M. Shuster, Great Falls, Mont.
- No. 674,917. Dumping cage, W. G. Halbert, Westville, Ill.
- No. 674,936. Furnace for the reduction of zinc ores, H. B. Meech, Denver, Colo.
- No. 675,056. Magnetic separator, T. A. Edison, Llewellyn Park, N. J.
- No. 675,057. Apparatus for screening pulverized material, T. A. Edison, Llewellyn Park, N. J.
- No. 675,058. Miner's combination tool, J. J. Elliot, Denver, Colo.
- No. 675,156. Conveyer, J. C. Hoshor, Paterson, N. J.
- No. 675,162. Magnetic separator, B. Noble, Detroit, Mich.
- No. 675,202. Rock-drilling machine, L. Durkee, Denver, Colo.
- No. 675,205. Process of treating blast-furnace slag in its molten state, A. D. Elbers, Hoboken, N. J.
- No. 675,264. Ore pulverizer, A. C. Calkins, Los Angeles, Cal.
- No. 675,281. Heating and roasting furnace, A. W. Johnson, Tacoma, Wash.
- No. 675,319. Rock drill, W. S. Boyd 3d, Los Angeles, Cal.
- No. 675,355. Tunneling device, W. S. MacHarg, Chicago, Ill.
- No. 675,265. Gyrotory muller, A. C. Calkins, Los Angeles, Cal.
- No. 675,123. Hydraulic Machine for Extracting Gold from Sand in Place, Grove S. Bartholomew, Los Angeles, Cal.
- No. 675,124. Apparatus for Extracting from River Beds, Charles H. Brown, Port Huron, Mich.
- No. 675,120. Method of Manufacturing Wrought Iron, Edwin D. Wassell, Pittsburg, Pa.



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